Appendix A – Maps

Map 1- Proposed Action Operations

Map 2 – Potential Strategic Fuels Treatment Locations (All Alternatives)

Map 3 – Alternative 2 Transportation System

Map 4 – Road Obliteration Map (All Alternatives)

Map 5 – Alternative 2 Post Treatment Transportation System

Map 6 – Existing Transportation System

Map 7 – Alternative 3 Operations

Map 8 – Alternative 3 Transportation System

Map 9 – Alternative 3 Post Treatment Transportation System

Map 10 – Alternative 4 Operations

Map 11 – Alternative 4 Transportation System

Map 12 – Alternative 4 Post Treatment Transportation System

Map 13 – Existing Fuels Treatment Projects within Project Boundary

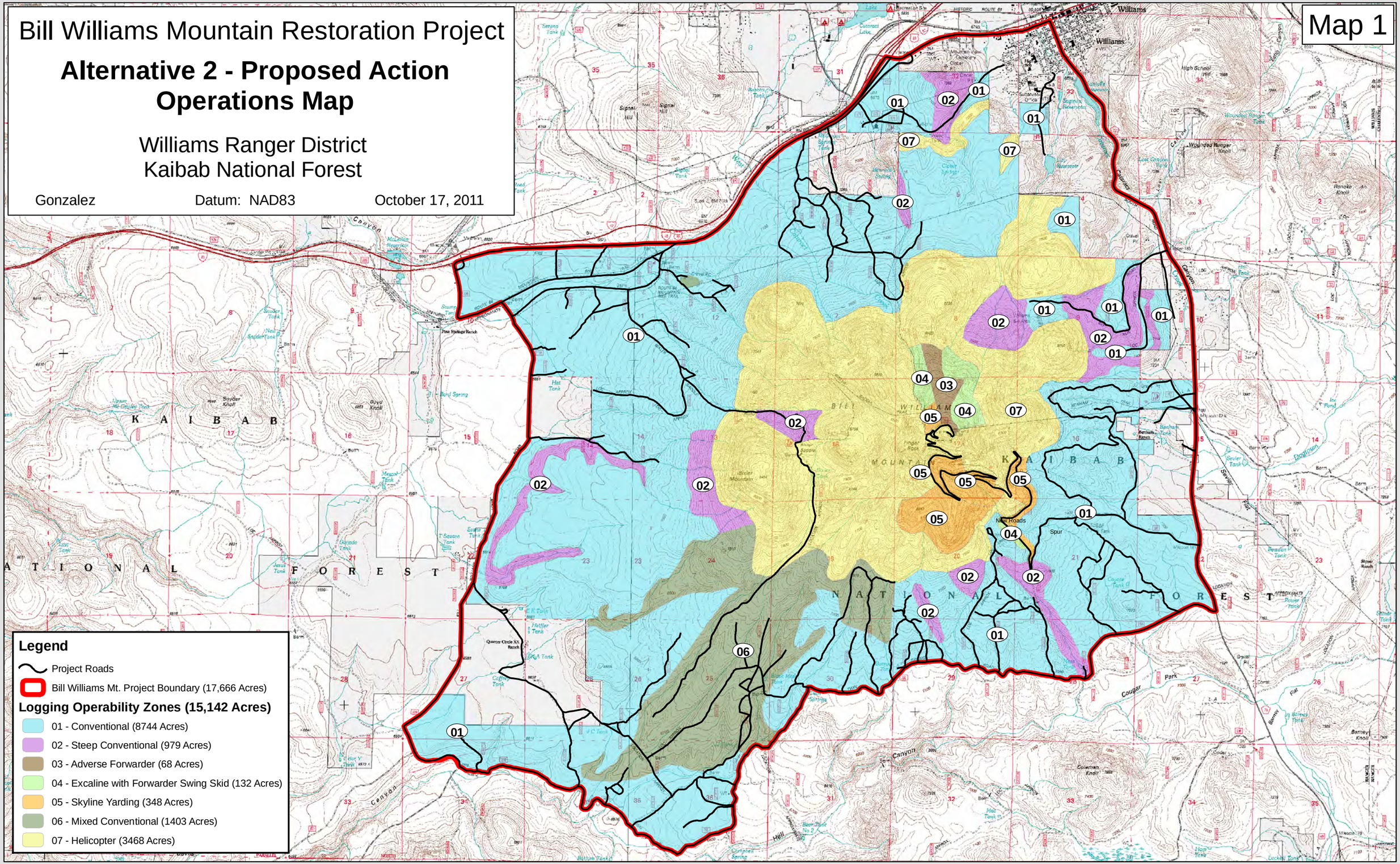
Bill Williams Mountain Restoration Project

Alternative 2 - Proposed Action Operations Map

Williams Ranger District
Kaibab National Forest

Gonzalez | Datum: NAD83 | October 17, 2011

Map 1



Legend

- Project Roads
- Bill Williams Mt. Project Boundary (17,666 Acres)

Logging Operability Zones (15,142 Acres)

- 01 - Conventional (8744 Acres)
- 02 - Steep Conventional (979 Acres)
- 03 - Adverse Forwarder (68 Acres)
- 04 - Excaline with Forwarder Swing Skid (132 Acres)
- 05 - Skyline Yarding (348 Acres)
- 06 - Mixed Conventional (1403 Acres)
- 07 - Helicopter (3468 Acres)

0 0.45 0.9 1.8 2.7 3.6 Miles

1:45,000

N

Map 2

Bill Williams Mountain Restoration Project

All Alternatives

Potential Strategic Fuels Treatment Locations*

Williams Ranger District
Kaibab National Forest

Gonzalez Datum: NAD83 October 17, 2011

Legend

- Fuel Treatment Control Lines
- Project Boundary

*This map illustrates the potential location of the strategic fuel treatments as described in all action alternatives. Mitigation measures have been developed should additional control lines be necessary.

0 0.45 0.9 1.8 2.7 3.6 Miles

1:45,000

N

Bill Williams Mountain Restoration Project

Alternatives 2
Transportation System Map

Williams Ranger District
Kaibab National Forest

French/Hancock Datum: NAD83 October 17, 2011

Map 3

Existing Roadbeds (73 miles)
Non-FS Jurisdiction (15 miles)
New Road Construction (23 miles)
Temporary (16 miles)
Project Boundary

0 0.375 0.75 1.5 Miles

1:45,000

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Bill Williams Mountain Restoration Project

All Alternatives
Road Obliteration Map

Williams Ranger District
Kaibab National Forest

French/Hancock Datum: NAD83 October 17, 2011

Map 4

Roads to Obliterate (28 miles)

Project Boundary

0 0.375 0.75 1.5 Miles

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Bill Williams Mountain Restoration Project

Alternatives 2
Post-Treatment Transportation System Map

Williams Ranger District
Kaibab National Forest

Map 5

New Bixler Trailhead and Parking Area

- Non-FS Jurisdiction Rd (15 miles)
- Open System Roads (29 miles)
- Maintenance Level 1 Roads (36 miles)
- Bixler Trail Extension (non-motorized)
- Project Boundary

0 0.25 0.5 1 Miles

1:45,000

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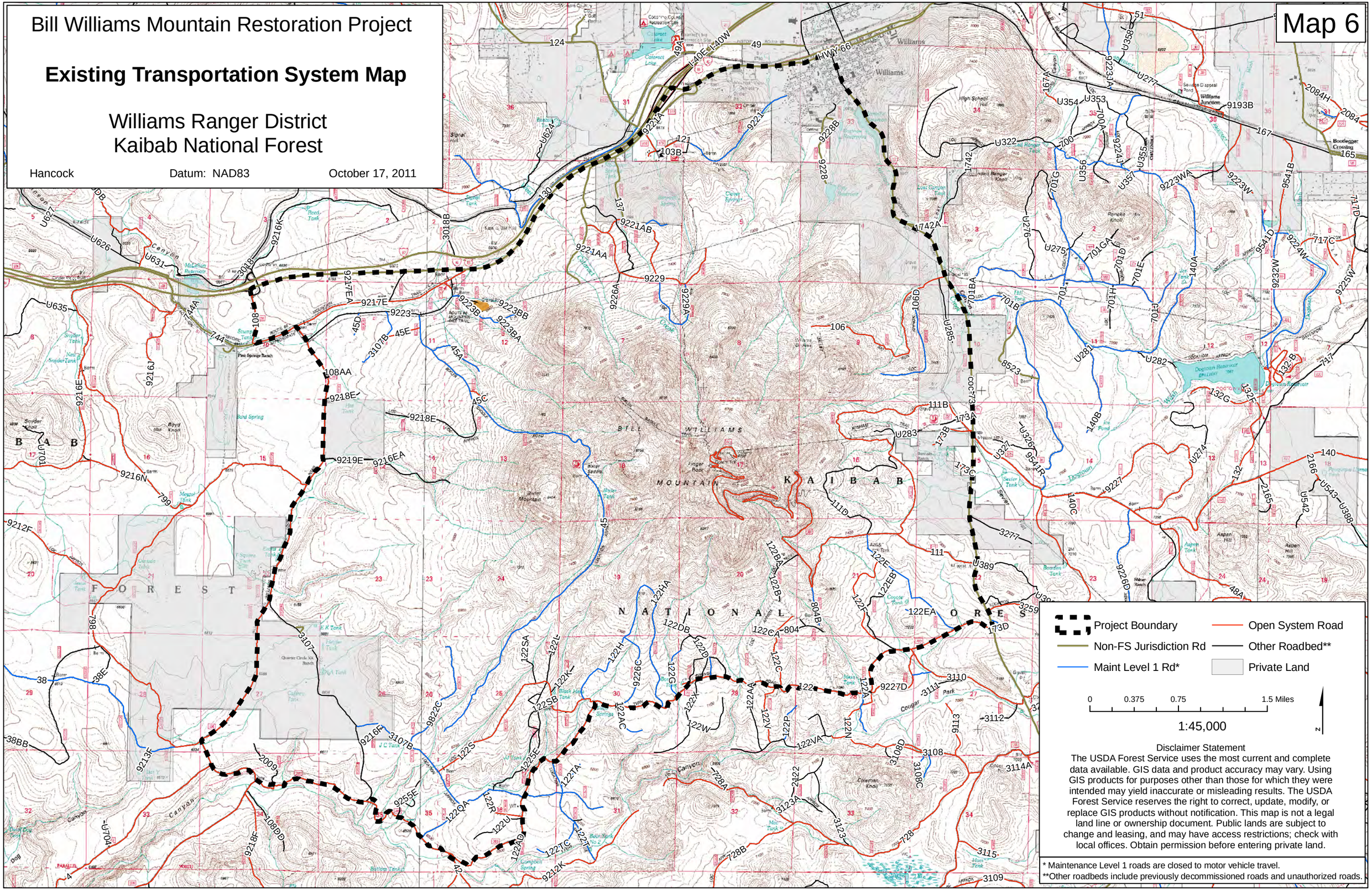
Bill Williams Mountain Restoration Project

Existing Transportation System Map

Williams Ranger District
Kaibab National Forest

Hancock | Datum: NAD83 | October 17, 2011

Map 6



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* Maintenance Level 1 roads are closed to motor vehicle travel.
**Other roadbeds include previously decommissioned roads and unauthorized roads.

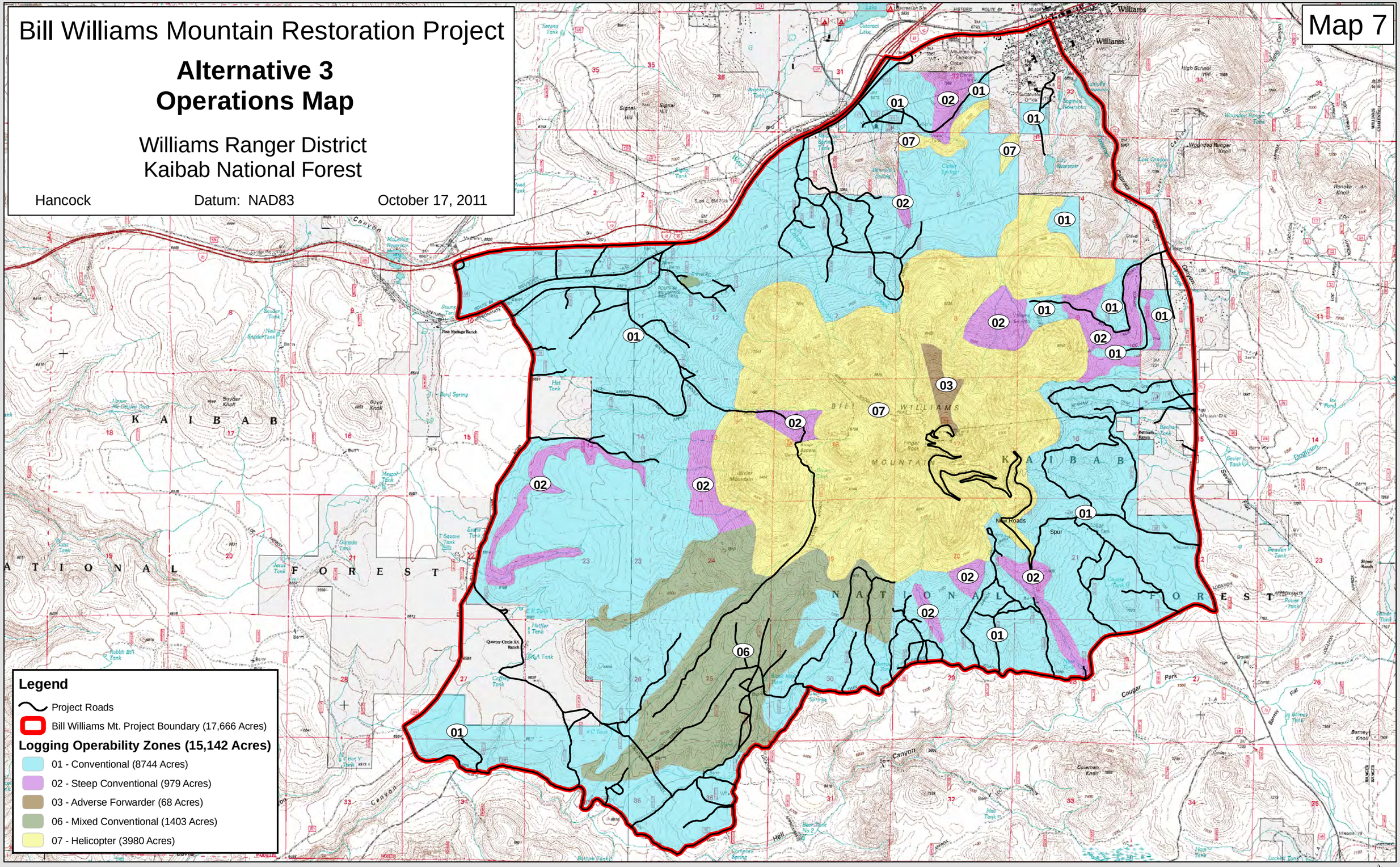
Bill Williams Mountain Restoration Project

Alternative 3
Operations Map

Williams Ranger District
Kaibab National Forest

Hancock | Datum: NAD83 | October 17, 2011

Map 7



Legend

- Project Roads
- Bill Williams Mt. Project Boundary (17,666 Acres)

Logging Operability Zones (15,142 Acres)

- 01 - Conventional (8744 Acres)
- 02 - Steep Conventional (979 Acres)
- 03 - Adverse Forwarder (68 Acres)
- 06 - Mixed Conventional (1403 Acres)
- 07 - Helicopter (3980 Acres)

0 0.45 0.9 1.8 2.7 3.6 Miles

1:45,000

N

Bill Williams Mountain Restoration Project

Alternatives 3
Transportation System Map

Williams Ranger District
Kaibab National Forest

French/Hancock Datum: NAD83 October 17, 2011

Map 8

Existing Roadbeds (73 miles)
Non-FS Jurisdiction (15 miles)
New Road Construction (22 miles)
Temporary (16 miles)
Project Boundary

0 0.375 0.75 1.5 Miles

1:45,000

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Bill Williams Mountain Restoration Project

Alternatives 3
Post-Treatment Transportation System Map

Williams Ranger District
Kaibab National Forest

Map 9

New Bixler Trailhead and Parking Area

- Non-FS Jurisdiction Rd (15 miles)
- Open System Roads (29 miles)
- Maintenance Level 1 Roads (35 miles)
- Bixler Trail Extension (non-motorized)
- Project Boundary

0 0.25 0.5 1 Miles

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Bill Williams Mountain Restoration Project

Alternative 4
Operations Map

Williams Ranger District
Kaibab National Forest

Hancock | Datum: NAD83 | October 17, 2011

Map 10

Legend

- Project Roads
- Bill Williams Mt. Project Boundary (17,666 Acres)

Logging Operability Zones (11,150 Acres)

- 01 - Conventional (8744 Acres)
- 02 - Steep Conventional (979 Acres)
- 06 - Mixed Conventional (1403 Acres)

0 0.45 0.9 1.8 2.7 3.6 Miles

1:45,000

N

Bill Williams Mountain Restoration Project

Alternatives 4
Transportation System Map

Williams Ranger District
Kaibab National Forest

Hancock Datum: NAD83 October 17, 2011

Map 11

Existing Roadbeds (73 miles)

Non-FS Jurisdiction (15 miles)

Temporary (38 miles)

Project Boundary

0 0.375 0.75 1.5 Miles

1:45,000

N W E S

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Bill Williams Mountain Restoration Project

Alternative 4
Post-Treatment Transportation System Map

Williams Ranger District
Kaibab National Forest

Hancock Datum: NAD83 October 17, 2011

Map 12

Non-FS Jurisdiction Rd (15 miles)

Open System Roads (29 miles)

Maintenance Level 1 Roads (16 miles)

Project Boundary

0 0.25 0.5 1 Miles

1:45,000

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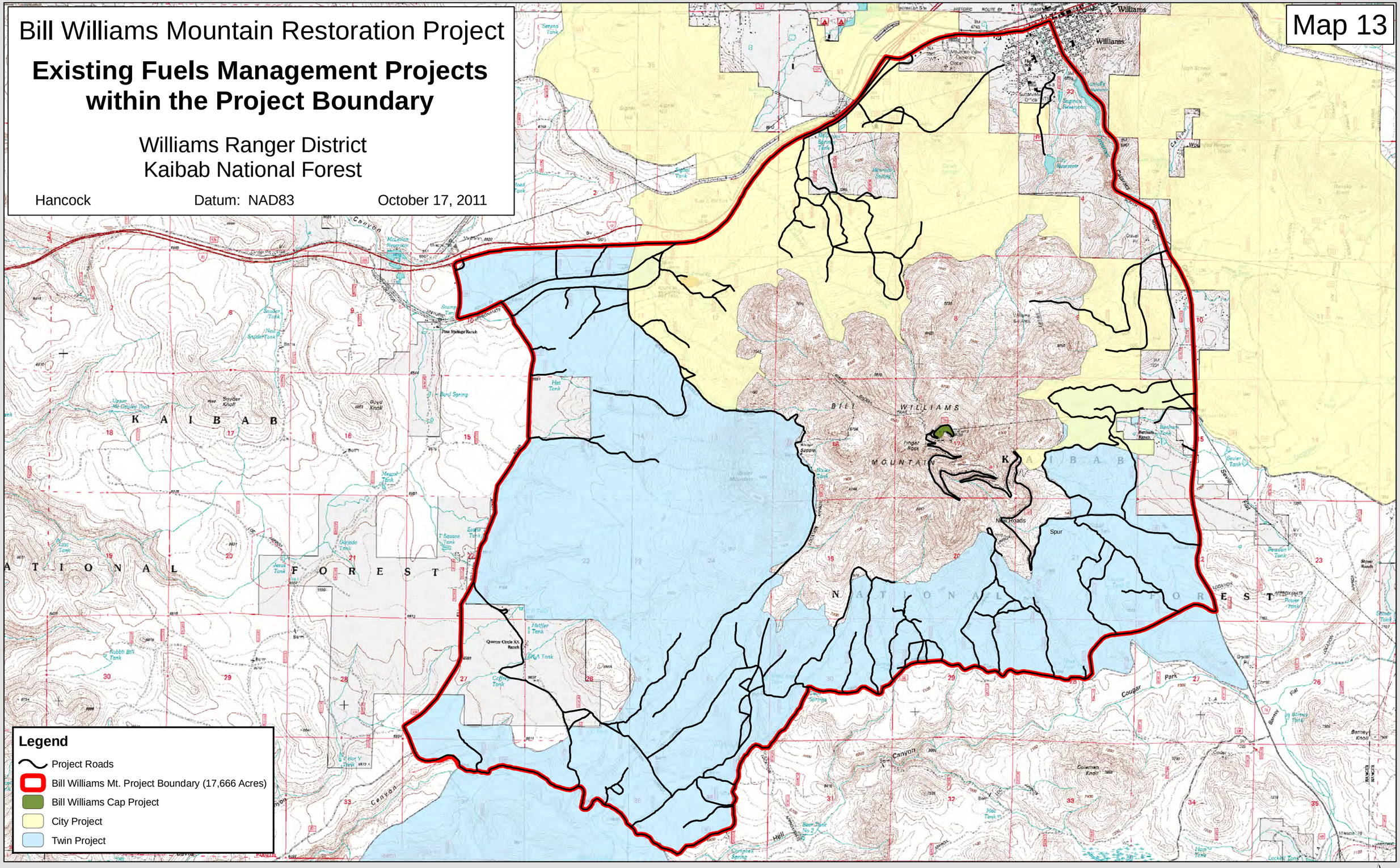
Bill Williams Mountain Restoration Project

Existing Fuels Management Projects within the Project Boundary

Williams Ranger District
Kaibab National Forest

Hancock | Datum: NAD83 | October 17, 2011

Map 13



Legend

- Project Roads
- Bill Williams Mt. Project Boundary (17,666 Acres)
- Bill Williams Cap Project
- City Project
- Twin Project

0 0.4 0.8 1.6 2.4 3.2 Miles

1:45,000

N

Appendix B – Soil and Watershed Best Management Practices

Resource protection measures listed below include references to standard SWCPs and BMP's found in the Soil and Watershed Conservation Practices Handbook (USDA, 1990). Resource protection measures are implemented to minimize nonpoint source pollution as outlined in the intergovernmental agreement between the Arizona Department of Environmental Quality and the Southwestern Region of the Forest Service (ADEQ, 2008). Note that no resource protection measures are required for the No Action Alternative. Table 3.4.4-1 provides a summary of soil and watershed protection measures for the Bill Williams Mountain Restoration Project.

Table 3.4.4-1. Resource Protection Measures Required for All Action Alternatives.

BMP #	Mitigation	Purpose	Effectiveness
BMP #1	Implement Best Management Practices where needed prior to project implementation.	To minimize impacts to soil and water resources from project implementation, to minimize non-point source pollution, to adhere to the Clean Water Act, and to adhere to the intergovernmental agreement between Region 3 of the Forest Service and the ADEQ.	1
BMP #2	On areas where prescribed fire is to be used, fire prescriptions should be designed to minimize soil temperatures over the entire treatment area. Fire prescriptions should be designed so that soil and fuel moisture temperatures are such that fire intensity is minimized and soil health and productivity are maintained. Broadcast burning should not be conducted in TES map units currently in unsatisfactory soil condition.	To maintain long-term soil productivity.	1
BMP #3	On areas where prescribed fire is to be implemented, retain approximately 3-7 tons/acre of course woody debris in ponderosa pine and pinyon stands to be left on-site after the prescribed burns and fuelwood gathering.	To maintain long-term soil productivity.	1
BMP #4	On areas to be prescribed burned, if containment lines are put in place, rehabilitate lines after use by installing fireline BMPs. If line is only to be waterbarred, disguise the first 300 feet	To minimize soil detachment and delivery to stream courses as sediment.	1

BMP #	Mitigation	Purpose	Effectiveness
	of line from roadways or otherwise restrict motorized access to discourage use.		
BMP #5	Do not blade roads when the road surface is too dry. If the road surface is too dry, water should be applied, or road blading should be scheduled when adequate moisture is present to complete road reshaping.	To minimize soil particle detachment and fugitive dust, and to ensure the longevity of road surface material.	2
BMP #6	All fueling of vehicles will be done on a designated upland site. If more than 1,320 gallons of petroleum products are to be stored on site or if a single storage tank exceeds 660 gallons, then a spill prevention control and countermeasures (SPCC) plan will be prepared as per 40 CFR 112.	To prevent contamination of soil and water resources from accidental petroleum hydrocarbon spills.	1
BMP #7	Clean all equipment prior to entry on site with a high pressure washer to remove mud, debris, and vegetative material from the equipment.	To minimize the spread of invasive or noxious weeds into the project area	1
BMP #8	Clean all equipment prior to leaving the project area with a high pressure washer to remove mud, debris, and vegetative material from the equipment.	To minimize the spread of invasive or noxious weeds to off-site areas and to prevent track-out of mud and debris onto public roadways.	1
BMP #9	Temporary access routes for fuelwood gathering should not have long, straight runs down slopes that would re-direct or concentrate water flow. These access routes should also be located out of filter strips (exceptions are at approved crossings).	To minimize the number of acres disturbed and to minimize potential adverse impacts to surface water quality.	1
BMP #10	Forest Service approved native seed should be broadcast over disturbed areas such as decommissioned roads, log landings, skid trails, and pile burning areas as necessary to stabilize soils. Seeding rates should be 8-10 lbs. per acre pure live seed. Recommended native species include: Western wheatgrass (*Pascopyrum smithii*)	To minimize soil loss and potential sedimentation of stream courses from harvesting operations and to minimize noxious weed spread and re-establish native vegetation	1

BMP #	Mitigation	Purpose	Effectiveness
	Arizona fescue (*Festuca arizonica*) mutton grass (*Poa fendleriana*) sideoats grama (*Bouteloua curtipendula*) blue grama (*Bouteloua gracilis*) mountain muhly (*Muhlenbergia montana*) winterfat (*Krascheninnikovia lanata*) Seeding should only be conducted where there is insufficient woody debris to protect soil surfaces from erosion in order to minimize possible introduction of invasive plant species. The seed mix can contain a mixture of all or some of these suggested species, depending on site considerations. Other acceptable erosion control measures include, but are not limited to, distributing slash, waterbarring (waterbars should not be more than two feet deep and require at least a ten foot leadout. Permanent water diversion structures are only to be installed using equipment with an articulating blade.		
BMP #11	Road drainage is controlled by a variety of methods including rolling the grade, insloping, outsloping, crowning, water spreading ditches (turnouts), and cross drainage. Sediment loads at drainage structures can be reduced by installing sediment filters such as rock and vegetative energy dissipaters, and settling basins.	To minimize soil movement and maintain water quality.	1
BMP #12	Do not operate equipment when ground conditions are such that soil rutting, compaction or puddling can occur.	To maintain long-term site productivity.	1
BMP #13	Treatment areas should be designed in a manner that minimizes soil disturbances and facilitates BMP implementation. TES maps should be reviewed for location of site specific BMP's in specified TES map units.	To maintain long-term soil productivity.	1
BMP #14	Activity generated slash from forest thinning are to be removed from stream courses and/or drainages. Trees are to	To protect surface water quality	1

BMP #	Mitigation	Purpose	Effectiveness
	be felled outside the stream courses and/or drainages and not across drainages.		
BMP #15	Do not hand pile slash in designated stream courses or drainages, or other designated protected areas.	To prevent organic matter loading of stream course and to prevent erosion and sedimentation of stream courses and water bodies.	1
BMP #16	Ensure that existing drainage structures on roads (rolling dips, culverts, rock crossings, etc.) are functioning correctly.	To prevent erosion and sedimentation of stream courses and water bodies.	1
BMP #17	Lead out ditches (turnouts) should be maintained in a manner that does not allow sediment laden runoff to enter stream courses and/or drainages.	To prevent erosion and sedimentation of stream courses and water bodies.	1
BMP #18	Adverse skidding (i.e., skidding upslope) should be avoided to the greatest extent practicable. Uphill yarding is preferred. Where downhill yarding is necessary, reasonable care shall be taken to lift the leading end of the log.	To prevent excess rutting and compaction of soil surfaces and minimize downhill movement of slash and soils.	1
BMP #19	Machine piling of activity-related slash should be conducted with an excavator or track hoe with a bucket thumb rather than dozers to prevent soil being pushed into burn piles and minimize soil disturbance.	To prevent excess rutting and compaction of soil surfaces.	1
BMP #20	Harvesting contractors should not be permitted to proceed to subsequent pay units until all necessary soil stabilization measures are implemented.	To maintain soil productivity across all activity sites throughout the project duration.	1
BMP #21	Primary skid trails should not occur within 1 chain (66 feet) of Streamside Management Zones or run parallel to stream courses in these areas.	To prevent excessive soil disturbance in areas close to drainages	1
BMP #22	Skidder crossings of ephemeral drainages should be minimized and designated in timber harvest area maps and on the ground	To prevent excessive soil disturbance in areas close to drainages and protect surface water quality	1

BMP #	Mitigation	Purpose	Effectiveness
BMP #23	Designated skid trails and log landings will be required within the Timber Sale Contract on all cutting units. Skid trail design should not have long, straight runs that would direct water flow. Skid trails should also be located out of filter strips (exceptions are at approved crossings).	To minimize the number of acres disturbed.	1
BMP #24	Felling to the lead will be required within the Timber Sale Contract (TSC) to minimize ground disturbance from skidding operations	Felling of timber should be done in a manner that minimizes ground disturbance from skidding operations.	1
BMP #25	On sites with impaired soils, do not prescribed burn without prior approval of a soil and water specialist.	To maintain vegetative ground cover and adequate organic matter to improve soil condition.	1
BMP #26	Where fuelwood sales are used to remove material, utilize created slash to cover and disguise temporary roads, minimize sediment movement from roads, and prevent unauthorized future use of temporary roads.	To minimize impacts from temporary roads by covering mineral soil, improving ground cover, providing a mulch for plant re-establishment and minimizing potential sediment movement by increasing surface roughness.	1
BMP #27	Use the following BMP techniques to minimize sedimentation from road and trail construction and maintenance: • Outsloped road surface; • Leadout ditches and relief culverts; • Energy dissipators on culverts; • revegetate cut and fill slopes; • Riprap installation at stream crossings to protect water quality; • Riprap or rock at intersections with paved public roads to prevent track-out of mud and debris	Minimize sediment delivery to stream courses from road and skid trail construction and maintenance. Protect public safety by preventing deposition of mud and debris onto paved public roads.	1

BMP #	Mitigation	Purpose	Effectiveness
	• Rolling grades.		
BMP #28	After use, all temporary roads will be ripped to a shallow depth (<6"), seeded using the seed mix specified in BMP #10, drained through installation of necessary water diversion structures and covered with slash from landings.	To return temporary roads to productivity	1
BMP #29	Locate new trail segments on-contour to the greatest extent possible. If cut and fill is required to establish serviceable trails, preferred drainage is outsloping of trail surfaces. Utilize additional drainage features outlined in BMP #27 in design and maintenance of the trail as warranted.	To minimize soil erosion from skid trails	1

In order to ensure that soil and watershed desired conditions are achieved and remain consistent with the Forest Plan, monitoring of soil disturbance caused by timber harvesting; use of prescribed fire; precommercial thinning (both mechanized and non-mechanized); road construction, maintenance and obliteration; and commercial and personal fuelwood gathering is advised. Best Management Practices (BMP) implementation monitoring and soil disturbance monitoring should be conducted following treatment activities in order to ensure proper implementation of BMPs to prevent erosion and sedimentation and to ensure activities are consistent with Forest Plan Standards and Guidelines. A recommended soil and watershed monitoring plan is summarized below.

Phase 1 – During Timber Harvest Activities

The timber sale administrator will monitor the implementation of BMP's during timber harvesting activities. Notes taken by the timber sale administrator will be used to track any issues or problems with BMP implementation. The Forest Soils and Watershed Specialist will provide assistance as needed by the timber sale administrator to provide clarification of BMP's specified in the Environmental Impact Statement (EIS).

Phase 2 – Timber Sale Closure
The timber sale administrator will verify that the timber sale purchaser has implemented all erosion control measures prior to the closure of the timber sale. Primary responsibility will be that of the timber sale administrator with assistance from the Forest Soils and Watershed Specialist if needed.

Phase 3 – Broadcast and Pile Burning
The District Fire Management Officer will verify that all erosion control measures associated with all burning activities has been implemented. The Forest Soils and Watershed Specialist will provide assistance, if needed.

Phase 4 – Effectiveness Monitoring
Within the first 5 years following timber sale closure, BMP's are evaluated for effectiveness. Monitoring will concentrate on such items as erosion control measures for skid trails, log landing or decking areas, road maintenance, road obliteration, and burned areas. The Forest Soils and Watershed Specialist will conduct a soil condition evaluation within cutting units. Focus on such items as vegetative ground cover, coarse woody debris, erosion, soil compaction, and soil displacement. All monitoring results are documented. Primary responsibility is with the District Ranger and the Forest Soils and Watershed Specialist.

Phase 5 – Follow Up
Documented information obtained from monitoring is used to adjust BMP's as necessary, to improve implementation and effectiveness of BMP's. Information regarding monitoring results and recommended changes to BMP's will be made available to the Arizona Department of Environmental Quality (ADEQ) for review as specified in the Intergovernmental Agreement between the State of Arizona and U.S Department of Agriculture, Forest Service Southwestern Region. Primary responsibility is with the District Ranger and the Forest Soils and Watershed Specialist.

Appendix C – Issue Processing Report

Bill Williams Mountain Restoration Project

Issue Processing Report

June 20, 2011

The following report was developed to document the interdisciplinary team's consideration of scoping comments. It documents how we identified significant and non-significant issues and why we eliminated non-significant issues from detailed study. Significant issues were carried forward and are addressed in the Environmental Impact Statement (EIS) (Section 1.6).

Issues serve to highlight effects or unintended consequences that may occur from the proposed action and alternatives, giving opportunities during the analysis to reduce adverse effects and compare trade-offs for the decision-maker and public to understand (FSH 1909.15, 12.4). An issue is not an activity in itself; instead, it is the projected effects of the activity that creates the issue.

The Forest Service reviewed all comments received in regards to scoping of the Proposed Action. A Notice of Intent was published in the Federal Register on Thursday, April 21, 2011. The NOI asked for public comment on the proposal by May 23, 2011. In addition, the Forest invited public comment and participation through listing of the project in the Schedule of Proposed Actions (SOPA); posting the scoping packet online (http://fs.usda.gov/goto/kaibab/projects); and mailing letters to potentially interested persons, tribal governments, and State and other Federal agencies. A scoping meeting was also hosted at the Williams Ranger District on Wednesday May 11, 2011 to discuss the proposed action and accept comments.

Each comment received was considered and evaluated to determine whether the issue was significant or non-significant. Significant issues were defined as those directly or indirectly caused by implementing the proposed action. Non-significant issues were identified as those: 1) outside the scope of the proposed action; 2) already decided by law, regulation, Forest Plan, or other higher level decision; 3) irrelevant to the decision to be made; or 4) conjectural and not supported by scientific or factual evidence. Some comments/issues were also considered non-significant because they would be addressed through routine analyses and/or processes.

Once comments were received (email, letter, phone call record, comment form, etc.), they were assigned a comment number (Appendix 1). The first number represents the document number (based on the order in which it was received) and the second number represents the individual comment/issue within that letter that required consideration (ex. issue number 3-4 was the sixth comment/issue the FS responded to within the third letter received). Each issue is summarized below and in bold text is the determination that was made regarding whether the issue was significant or non-significant and how it was resolved. This process is documented in the following pages.

Issue Processing Results

1-1 I support the project and any efforts to improve forest health.
Non-Significant Issue – This comment is supportive of the project.

2-1 Please continue to consult with the Hopi Tribe on this project.
Non-Significant Issue – The Kaibab National Forest routinely consults with the Hopi Tribe and will continue to do so with this project. Documentation of our consultation efforts will be presented in Chapter 4 of the EIS.

3-1 Removing most of the dead trees, both standing and fallen, will greatly reduce the fire danger.
Non-Significant Issue – The purpose and need for the project recognizes the need to reduce fuel buildup and reduce the risk for intense stand-replacing wildland fires. The proposed action was developed to meet the purpose and need.

3-2 Prescribed burning will increase debris flow and increase surface erosion. The water treatment plant will not be able to remove debris and burned smell in the runoff.
Significant Issue – The effects from prescribed burning will be analyzed and discussed in the EIS. Implementation of Soil and Watershed Best Management Practices (BMPs) will reduce the likelihood of erosion problems.

3-3 Prescribed burning will affect unique plants such as the ferns about one mile up the Benham Trail.
Non-Significant Issue – The effects from prescribed burning on rare plants will be analyzed and discussed in the EIS. Ferns are not a Threatened and Endangered Species (TES); Forest Service Sensitive Species; nor a Management Indicator Species (MIS).

3-4 The project will increase sediment loads which will impact the water quality of my well.
Non-Significant Issue – The effects from prescribed burning will be analyzed and discussed in the EIS. Implementation of Soil and Watershed Best Management Practices (BMPs) will reduce the likelihood of erosion problems.

4-1 There may be changes to the chemistry of the local water supply.
Non-Significant Issue – The effects to water quality will be analyzed and discussed in the EIS.

4-2 This burning portion of this project cannot be completed safely.
Non-Significant Issue – While safety is very important and there are inherent risks when conducting prescribed burning efforts, the Forest believes it can successfully implement the prescribed burning safely. Safety considerations will also be addressed in any prescribed burn plan that will be developed for this project.

4-3 This project will cost too much money.
Non-Significant Issue – The EIS will discuss the economic impacts of the proposed action and alternatives analyzed in detail. Implementation of the project will be dependent on available funding and market conditions which are outside the scope of the project.

4-4 Do mechanical thinning for the first treatment, then burn.
Non-Significant Issue – The proposed action includes strategic fuel treatments which will be implemented prior to any prescribed burning. Implementation of the mechanical treatments will be dependent on available funding and market conditions which are outside the scope of the project.

4-5 There should be a campfire ban around the base of the mountain at least until this project is completed.
Non-Significant Issue – The decision to implement a campfire ban in the project area is outside the scope of this project. While a campfire ban can reduce the risk for an intense stand-replacing wildland fire, it in no other way would meet the purpose and need for action nor would it assist the Forest in meeting or moving towards the desired conditions for the area.

4-6 Free use firewood areas should be indentified.
Non-Significant Issue – Firewood collection is already a part of the proposed action (Post-mechanical Treatments). The permitting of forest products is outside the scope of the proposed action.

4-7 The project may hurt mixed conifer and wildlife areas.
Non-Significant Issue – The effects to mixed confer stands and wildlife areas will be disclosed in the EIS.

4-8 The project needs to be completed asap.
Non-Significant Issue – Implementation of the project would begin in 2012 and would occur as funding and/or favorable conditions allow.

4-9 Any effort to leave pre-settlement and old growth trees?
Significant Issue - A mitigation measure has been developed to retain pre-settlement and old growth trees where possible. Some pre-settlement and old growth trees may be incidentally taken to allow harvesting activities to occur.

4-10 Where will you get the funding to complete the project?
Non-Significant Issue – Funding for the project is dependent on Congress and is an issue outside the scope of the project.

4-11 Is it going to be easy to sell the timber?
Non-Significant Issue – The selling of the timber is dealt with as a part of implementation of the project and an economic analysis will be done as part of the EIS.

4-12 What are you doing about aspen restoration?
Non-Significant Issue – The treatment of Aspen is addressed in the project proposal.

4-13 Concerned that fuel loading is getting worse up there.
Non-Significant Issue – The Purpose and Need for Action identifies the need for reduced fuel loadings.

4-14 You should start the project in Zone 1 now instead of waiting for approval of whole project.
Non-Significant Issue – Implementation of the project would begin in 2012 and would occur as funding and/or favorable conditions allow.

4-15 Are there going to be diameter caps on timber removed?
Significant Issue - A mitigation measure has been developed to retain pre-settlement and old growth trees where possible. Some pre-settlement and old growth trees may be incidentally taken to allow harvesting activities to occur.

4-16 Prescribed burning will result in increased ash filling Benham tanks.

Significant Issue – The effects from prescribed burning will be analyzed and discussed in the EIS. Implementation of Soil and Watershed Best Management Practices (BMPs) will reduce the likelihood of erosion problems.

4-17 Vertical arrangement of Strategic fire lines around blocks may result in erosion problems.
Significant Issue – The effects of the strategic fuel treatments will be analyzed and discussed in the EIS. Implementation of Soil and Watershed Best Management Practices (BMPs) will reduce the likelihood of erosion problems.

4-18 Are we removing riparian or wetland vegetation during project?
There are no riparian areas or wetland vegetation in the project area and implementation of the project will follow Forest Plan guidance and BMPs.

4-19 Map #5 needs to be corrected to show consistent road lengths that will be open or closed after project.
Non-Significant Issue – The maps will be updated as the planning process continues.

5-1 The purpose and need can be met without the 3 site-specific FP amendments.
Significant Issue – This issue suggests an alternative with no Forest Plan amendments.

5-2 Prescribed burning can be used to a greater degree with less vegetation manipulation.
Significant Issue – This issue suggests an alternative with limited mechanical treatments or a burn only alternative.

5-3 There should be a 16" diameter cap on the cutting of ponderosa pine.
Non-Significant Issue – The agencies experience and interpretation of the best available science does not support the claim that we can adequately meet the purpose and need for action with a 16" diameter cap. However, a mitigation measure has been developed to retain pre-settlement and old growth trees where possible. Some pre-settlement and old growth trees may be incidentally taken to allow harvesting activities to occur. The effects to pre-settlement and old growth trees will be analyzed and discussed in the EIS.

5-4 Our preferred management approach (see the Citizen's Alternative) should be used.
Non-Significant Issue – The suggested alternative was considered in whole and in part and did not present any issues other than those already considered in this report. An alternative was considered but eliminated from detailed study to reflect the suggested alternative.

5-5 There should be no temporary or new road construction to protect the watershed. Hand crews can be used in areas with no road access.
Significant Issue – Implementation of Soil and Watershed Best Management Practices (BMPs) would reduce the potential for impacts from road construction to the watershed.

5-6 There should be an action alternative that does not include site-specific FP amendments.
Significant Issue – This issue suggests an alternative with no Forest Plan amendments.

5-21 There should be an action alternative that would place a 16" diameter cap on ponderosa pine.
Non-Significant Issue – The agencies experience and interpretation of the best available science does not support the claim that we can adequately meet the purpose and need for action with a 16" diameter cap. However, a mitigation measure has been developed to retain pre-settlement and old growth trees where possible. Some pre-settlement and old growth trees may be incidentally taken

to allow harvesting activities to occur. The effects to pre-settlement and old growth trees will be analyzed and discussed in the EIS.

5-7 The EIS must consider a statistically-valid risk of catastrophic fire as well as the required maintenance schedule and costs to keep that risk low against the impacts from logging on other resources.
Non-Significant Issue – This issue will be resolved through routine analysis of the alternatives in the EIS.

5-8 You must account for cumulative effects of fuels treatments over time.
Non-Significant Issue – This issue will be resolved through routine analysis of the alternatives in the EIS.

5-9 You must realize that with climate change, it may be impossible to stop uncharacteristic wildfire and spending money on expensive management actions may be futile.
Non-Significant Issue – This issue will be resolved through routine analysis of the alternatives in the EIS.

5-10 It is a false assumption to think the no-action alternative will result in crown fires.
Non-Significant Issue – This issue will be resolved through routine analysis of the alternatives in the EIS.

5-11 Cutting large trees to reduce fuels is contrary to fuels reduction or forest restoration objectives.
Non-Significant Issue – The agencies experience and interpretation of the best available science does not support the claim that we can adequately meet the purpose and need for action without cutting large trees. A mitigation measure has been developed to retain pre-settlement and old growth trees where possible. Some pre-settlement and old growth trees may be incidentally taken to allow harvesting activities to occur. The effects to pre-settlement and old growth trees will be analyzed and discussed in the EIS.

5-12 There is lack of empirical evidence supporting mechanical fuels reduction treatments will reduce the severity of wildfire and the FS is required by NEPA to disclose and discuss this "responsible opposing view."
Non-Significant Issue – This issue will be resolved through routine analysis of the alternatives in the EIS.

5-13 All large trees should be retained because a 16" diameter cap will achieve crown fire hazard prevention.
Non-Significant Issue – The agencies experience and interpretation of the best available science does not support the claim that we can adequately meet the purpose and need for action with a 16" diameter cap. However, a mitigation measure has been developed to retain pre-settlement and old growth trees where possible. Some pre-settlement and old growth trees may be incidentally taken to allow harvesting activities to occur. The effects to pre-settlement and old growth trees will be analyzed and discussed in the EIS.

5-14 Failure to discuss the findings of Odion et al. 2004 and Perry et al. 2004 regarding crown fire is a violation of NEPA.
Non-Significant Issue – This issue will be resolved through routine analysis of the alternatives in the EIS.

5-15 The FS must consider the cost-effectiveness of the treatments, in particular, mechanical treatment versus prescribed fire.

Non-Significant Issue – This issue will be resolved through routine analysis of the alternatives in the EIS.

5-16 The FS must consider in detail the impacts on forestlands from grazing activities.
Non-Significant Issue – This issue will be resolved through routine analysis of the alternatives in the EIS.

5-17 The FS must fully disclose the cumulative effects of livestock grazing, timber harvest, fuel break construction, thinning, prescribed fire, and road developments on water quality, forest health, wildlife habitat, noxious weeds, cultural resources, and other resources.
Non-Significant Issue – This issue will be resolved through routine analysis of the alternatives in the EIS.

5-18 The FS must provide documentation that it is in compliance with NEPA regulations including the requirement that the Service analyze the cumulative effects on this and other projects on various terrestrial and aquatic wildlife species and various plant species.
Non-Significant Issue – This issue will be resolved through routine analysis of the alternatives in the EIS.

5-19 NFMA requires the FS to analyze impacts to Forest Plan Management Indicator Species as found in the LMP.
Non-Significant Issue – This issue will be resolved through routine analysis of the alternatives in the EIS.

5-20 The FS cannot sign the ROD until after the USFWS has completed the new consultation on the Forest Plans and their effect on the MSO.
Non-Significant Issue – This issue will be resolved through routine analysis of the alternatives in the EIS. Consultation with the USFWS will be conducted in accordance with the Endangered Species Act.

5-21 WildEarth Guardians requests the FS consider their Citizen's Alternative described in their comment letter pages 9-16.
Non-Significant Issue – The suggested alternative was considered in whole and in part and did not present any issues other than those already considered in this report. An alternative was considered but eliminated from detailed study to reflect the suggested alternative.

6-1 Keep in mind that the use of prescribed fire may result in an increase in ash into the water treatment plant for the City of Williams. How will this increase affect the water supply?
Significant Issue – The effects from prescribed burning will be analyzed and discussed in the EIS. Implementation of Soil and Watershed Best Management Practices (BMPs) will reduce the likelihood of erosion problems.

7-1 Propose a campfire ban in project area with the boundary being FR 108 at least until the project is implemented and completed.
Non-Significant Issue – The decision to implement a campfire ban in the project area is outside the scope of this project. While a campfire ban can reduce the risk for an intense stand-replacing wildland fire, it in no other way would meet the purpose and need for action nor would it assist the Forest in meeting or moving towards the desired conditions for the area.

8-1 Leave some of the mountain as wild as you can for recreation.

Non-Significant Issue – The management of the project area is defined in and guided by the 1988 Kaibab Land and Resource Management Plan (as amended). The effects to recreation resources will be analyzed and discussed in the EIS.

8-2 Open the area up to free use permits for the removal of forest products prior to implementation.
Non-Significant Issue – Firewood collection is already a part of the proposed action (Post-mechanical Treatments). The permitting of forest products is outside the scope of the proposed action.

9-1 Thin to pre-settlement conditions starting with Zones 1 and 2 and along South Perkinsville and FR 40 first.
Non-Significant Issue – Implementation of the project would begin in 2012 and would occur as funding and/or favorable conditions allow.

9-2 Use mechanical thinning first before fire treatments for better control.
Non-Significant Issue – The proposed action includes strategic fuel treatments which will be implemented prior to any prescribed burning. Implementation of the mechanical treatments will be dependent on available funding and market conditions which are outside the scope of the project.

9-3 Open the project area up to firewood cutters.
Non-Significant Issue – Firewood collection is already a part of the proposed action (Post-mechanical Treatments). The permitting of forest products is outside the scope of the proposed action.

10-1 Be careful with treatments on the slopes and ravines to prevent runoff and erosion.
Non-Significant Issue – This issue will be resolved through routine analysis of the alternatives in the EIS. Implementation of Soil and Watershed Best Management Practices (BMPs) will reduce the likelihood of erosion problems.

10-2 Habitat areas for MSO, goshawks and peregrine falcons will need to be treated very carefully.
Non-Significant Issue – This issue will be resolved through routine analysis of the alternatives in the EIS.

10-3 Keep a night patrol on prescribed burns for safety reasons.
Non-Significant Issue – While safety is very important and there are inherent risks when conducting prescribed burning efforts, the Forest believes it can successfully implement the prescribed burning safely. Safety considerations will also be addressed in any prescribed burn plan that will be developed for this project.

10-4 Provide firewood opportunities for local use and sales.
Non-Significant Issue – Firewood collection is already a part of the proposed action (Post-mechanical Treatments). The permitting of forest products is outside the scope of the proposed action.

11-1 Wildlife areas will need to get the necessary attention particularly habitat for bobcats, goshawks, peregrine falcons and MSO.
Non-Significant Issue – This issue will be resolved through routine analysis of the alternatives in the EIS.

12-1 The decades long downsizing of the FS is the underlying problem in making the mountain able to survive fire. This political agenda is harmful to our public lands.
Non-Significant Issue – Politics and the agencies administration of human resources is outside the scope of the project.

13-1 Protect goshawk and MSO habitat.
Non-Significant Issue – This issue will be resolved through routine analysis of the alternatives in the EIS.

13-2 Maintain recreational opportunities.
Non-Significant Issue – This issue will be resolved through routine analysis of the alternatives in the EIS.

13-3 Protect T&E plants.
Non-Significant Issue – This issue will be resolved through routine analysis of the alternatives in the EIS and is to some degree already required/resolved by existing laws and regulations.

13-4 I am concerned about an increase in invasive weeds.
Non-Significant Issue – This issue will be resolved by implementation of Forest Plan Standards and Guidelines as well as Best Management Practices.

13-5 I am concerned about smoke impacts to residents.
Non-Significant Issue – This issue will be resolved through routine analysis of the alternatives in the EIS. Implementation of prescribed burning efforts will be approved by the Arizona Department of Environmental Quality (ADEQ) and will include public notices of the prescribed burning efforts.

13-6 Protect cultural resources.
Non-Significant Issue – This issue will be resolved through routine analysis of the alternatives in the EIS. Mitigation measures have been developed to protect cultural resources.

13-7 The project should restore and maintain healthy aspen groves.
Non-Significant Issue – The treatment of Aspen is addressed in the project proposal.

13-8 The project should provide opportunities for fuelwood utilization, both commercial and personal use.
Non-Significant Issue – Firewood collection is already a part of the proposed action (Post-mechanical Treatments). The permitting of forest products is outside the scope of the proposed action.

13-9 Minimize expansion of unmaintained roads.
Non-Significant Issue – A part of the purpose and need for action includes improving the motorized transportation system to provide for a more sustainable road system where poorly located roads are relocated or obliterated.

13-10 The project should protect and promote the growth of Native American medicinal and ceremonial plants.
Significant Issue – A mitigation measures will be developed to protect and promote the growth of Native American medicinal and ceremonial plants in consultation with the Tribes.

13-11 Treatments in the lower elevation ponderosa pine should aggressively thin and burn stands with the objective of returning to reference conditions.

Non-Significant Issue – This issue is already a part of the purpose and need for action.

13-12 Maximum utilization of wood products is desirable.
Non-Significant Issue – This issue will be resolved through routine analysis of the alternatives in the EIS.

13-13 The greatest challenge is to maintain mixed conifer stands while reducing the potential for stand replacing fire.
Non-Significant Issue – This issue will be resolved through routine analysis of the alternatives in the EIS.

13-14 Care will be required to balance hazard fuel reduction with other values and aesthetics.
Non-Significant Issue – This issue will be resolved through routine analysis of the alternatives in the EIS.

14-1 Temporary roads constructed on slopes have the potential to create more sediment per mile during precipitation events than system roads. Please do not construct any temporary roads for this project.
Significant Issue – Implementation of Soil and Watershed Best Management Practices (BMPs) would reduce the potential for impacts from road construction to the watershed.

14-2 Proposed roads will affect wildlife. Reduce all impacts from road construction.
Significant Issue – The issue suggests an alternative with no new road construction. Implementation of Soil and Watershed Best Management Practices (BMPs) would reduce the potential for impacts from road construction to the watershed.

14-3 Science indicates that timber harvest activities cause resource damage.
Non-Significant Issue – As part of the Environmental Impact Statement we will discuss the impacts of the harvest activities proposed and the responsible official will consider those impacts when making their decision.

14-4 If noxious weed treatment is planned, do not use herbicides containing glyphosate.
Non-Significant Issue – This issue will be resolved implementation of the "Design Features, Best Management Practices, and Mitigation Measures" identified in the "Final Environmental Impact Statement for Integrated Treatment of Noxious or Invasive Weeds on the Coconino, Kaibab, and Prescott National Forests within Coconino, Gila, Mojave, and Yavapai Counties, Arizona" (2004).

15-1 If the mountain is control burned, the run-off is known to affect the water quality in the surrounding lakes and the City's ability to properly treat this water. Please conduct a study on the effects of control burning on water quality.
Significant Issue – The effects from prescribed burning will be analyzed and discussed in the EIS. Implementation of Soil and Watershed Best Management Practices (BMPs) will reduce the likelihood of erosion problems.

16-1 A strategic treatment design must be incorporated into the project to retain and maintain structural integrity of forest habitat, such as key placements of fewer target treatments along with a prescribed burning plan to achieve restoration goals.
Non-Significant Issue – Prescribed burning and treatment areas are designed and strategically located to retain and maintain structural integrity of forested habitats.

16-2 Consider previous treatments in the project area and vicinity to determine thinning treatment areas.
Non-Significant Issue – This issue will be resolved through routine analysis of the alternatives and cumulative effects in the EIS.

16-3 We recommend including recommendations developed from the recent Forest Health Focus effort.
Non-Significant Issue – The Bill Williams Mtn area was identified in the Forest Health Focus effort as priority area for treatment.

16-4 The DEIS should disclose if an MSO PAC exists in the project area and the effects of the project to the PAC. We recommend that the project enhances and protects MSO habitat within a PAC as recommended in the MSO Recovery Plan.
Significant Issue – The EIS will disclose the effects and affected environment for Mexican Spotted Owls, however this comment suggests an alternative that would not amend the Forest Plan.

16-5 A portion of the project area cover type is pine-oak. We recommend working with the FWS to identify MSO pine-oak habitat to ensure treatments will benefit the MSO and restore the area.
Non-Significant Issue – This issue will be resolved through routine analysis of the alternatives in the EIS.

16-6 The MSO Recovery Plan identifies mixed conifer cover type and also refers to Douglas-fir and white fir cover types. To assist the FS in identifying MSO habitat and potential treatments, we recommend describing the project area in terms of mixed conifer cover type as defined in the MSO Recovery Plan.
Non-Significant Issue – This issue will be resolved through routine analysis of the alternatives in the EIS.

16-7 We recommend including MSO protected and restricted habitat as a discussion to avoid confusion in the desired condition section.
Non-Significant Issue – This issue will be resolved through routine analysis of the alternatives in the EIS.

16-8 Desired Condition section also confounds MSO guidelines and northern goshawk guidelines. Northern goshawk guidelines are also presented as desired conditions for mixed conifer (particularly within MSO protected and target/threshold habitat) with no reference to guidelines described in the MSO Recovery Plan. We encourage the USFS to refer to the MSO Recovery Plan management recommendations (Volume I/Part III; pp.82-96), and primary constituent elements found in the final rule designating MSO critical habitat (August 31, 2004; 69 FR 53232).
Non-Significant Issue – This issue will be resolved through routine analysis of the alternatives in the EIS.

16-9 We recommend the USFS follow the management guideline recommendations for each category of MSO habitat (PAC, protected steep slope, target/threshold, and restricted) and critical habitat as described in the MSO Recovery Plan and the final rule designating critical habitat.
Significant Issue – The EIS will disclose the effects and affected environment for Mexican Spotted Owls, however this comment suggests an alternative that would not amend the Forest Plan. Following the guidelines for conservation of critical habitat requires 40% shade.

16-10 In the scoping document, the section on desired conditions for ponderosa pine and mixed conifer cover types suggests the desired conditions are driven by management guidelines for the northern

goshawk. However, in areas where the guidelines conflict with MSO Recovery Plan recommendations in MSO habitat (pine-oak and mixed conifer), we encourage the MSO Recovery Plan recommendations take precedence.
Non-Significant Issue – This issue is already decided by the 1988 Kaibab Land and Resource Management Plan (as amended); MSO guidelines supersede goshawk guidelines in areas of overlap.

16-11 A desired condition for both ponderosa pine and mixed conifer cover types states large trees of all species will be developed throughout the cover type. The pine-oak and mixed conifer cover types likely contain many large trees, a key habitat component of MSO habitat and a primary constituent element of MSO critical habitat. We recommend the proposed action be designed to maintain this key habitat component and primary constituent element.
Significant Issue - A mitigation measure has been developed to retain pre-settlement and old growth trees where possible. Some pre-settlement and old growth trees may be incidentally taken to allow harvesting activities to occur.

16-12 A desired condition for both ponderosa pine and mixed conifer cover types states fuel loading will average 5 to 7 tons per acre in northern goshawk habitat in those cover types. We recommend the Restoration Project be designed to retain a sufficient amount of large logs and other dead and down material compatible with MSO needs and primary constituent elements of MSO critical habitat, while meeting forest restoration objectives. We also recommend the USFS refer to Brown et al. (2003) and Graham et al. (2004) regarding the amount of coarse woody debris needed to maintain soil health in ponderosa and mixed conifer forests in northern Arizona.
Significant Issue - A mitigation measure has been developed to retain large down logs and woody debris where possible. Where possible we will avoid direct ignition of large down logs and woody debris in the project area to meet desired conditions.

16-13 The scoping document states sites with dwarf mistletoe left unmanaged in the area cannot be maintained in a sustainable, uneven-aged condition. We understand there is a need to manage dwarf mistletoe as part of forest restoration objectives, and we recommend including an objective to support uneven-aged management in dwarf mistletoe-infected stands.
Non-Significant Issue – The proposed action will do uneven-aged management in infected sites. Sometimes in highly infected sites it may be necessary to do even-aged treatments.

16-14 The Arizona bugbane is a sensitive species for which a conservation strategy and agreement was developed. Additional measures may be needed to protect this species during implementation of the Restoration Project. We encourage the USFS to implement the terms of the conservation strategy and agreement as part of the proposed action.
Non-Significant Issue – This issue is already decided by the 1988 Kaibab Land and Resource Management Plan (as amended).

16-15 The State of Arizona and various American Indian Tribes maintain lists of sensitive species that may not be protected by Federal law. We recommend you contact the Arizona Game and Fish Department (AGFD) and any affected tribe to determine if sensitive species may occur in the action area. We encourage the USFS to invite the AGFD and any affected tribe to participate in the review of your proposed action.
Non-Significant Issue – This issue will be resolved through routine analysis of the alternatives in the EIS. The proposed action was scoped to the AGFD and Tribal consultation on the proposed action is ongoing.

16-16 Maintain mixed conifer habitat and avoid removing important components (white fir, Douglas-fir, and other mixed conifer tree species).

Non-Significant Issue – This issue will be resolved through routine analysis of the alternatives in the EIS. Mixed conifer stands will be maintained under the proposed action.

16-17 Maintain pre-settlement/old-growth trees.
Significant Issue - A mitigation measure has been developed to retain pre-settlement and old growth trees where possible. Some pre-settlement and old growth trees may be incidentally taken to allow harvesting activities to occur.

16-18 Maintain pine-oak habitat within MSO PACs.
Significant Issue – The EIS will disclose the effects and affected environment for Mexican Spotted Owls, however this comment suggests an alternative that would not amend the Forest Plan.

16-19 Maintain mixed conifer stands containing aspen as mixed conifer habitat described in the MSO Recovery Plan.
Non-Significant Issue – This issue will be resolved through routine analysis of the alternatives in the EIS. Mixed conifer stands will be maintained under the proposed action.

17-1 The Center requests that the Forest Service study, develop, and describe an alternative that would meet the purpose and need for action while conserving trees larger than 16-inches diameter at breast height ("dbh") outside of a well-defined wildland-urban interface ("WUI") zone comprising one-quarter (¼) mile distance from established residential and other community infrastructure.
Non-Significant Issue – The agencies experience and interpretation of the best available science does not support the claim that we can adequately meet the purpose and need for action with a 16" diameter cap. A mitigation measure has been developed to retain pre-settlement and old growth trees where possible. Some pre-settlement and old growth trees may be incidentally taken to allow harvesting activities to occur. The effects to pre-settlement and old growth trees will be analyzed and discussed in the EIS.

17-2 Large tree removal should be a significant issue in the forthcoming environmental impact statement to account for potentially significant impacts to forest vegetation, old growth recruitment, and wildlife habitat. *See* 40 C.F.R. § 1508.27.
Significant Issue - A mitigation measure has been developed to retain pre-settlement and old growth trees where possible. Some pre-settlement and old growth trees may be incidentally taken to allow harvesting activities to occur.

17-3 Fuel treatments should be designed with spatial patterns of fire spread in mind. The agency's science and experience show that fuel management can be unnecessary and counterproductive if it is not spatially arranged to take advantage of site-specific topography and weather patterns (Finney 2001). Moreover, Peterson and Johnson (2007) posed questions regarding the efficacy of different fuel treatment options at various spatial scales that should be addressed in the project analysis.
Non-Significant Issue – This issue will be resolved through routine analysis of the alternatives in the EIS.

17-4 To the degree that the project also may increase the effectiveness of fire suppression, the analysis must consider effects on the environment resulting from connected and cumulative fire suppression activities (Backer et al. 2004).
Non-Significant Issue – This issue will be resolved through routine analysis of the alternatives in the EIS.

17-5 Many forest animals are threatened by large scale fires and habitat degradation associated with silvicultural management in dwarf mistletoe stands.

Significant Issue - A mitigation measure has been developed to retain some dwarf mistletoe as a natural component in stands.

17-6 The Forest Service must ensure that the project will not adversely affect goshawk or contribute to a trend toward listing under the Endangered Species Act.
Non-Significant Issue – This issue will be resolved by implementation of Forest Plan Standards and Guidelines and will also be resolved through analysis of the alternatives in the EIS.

17-7 The Kaibab National Forest developed a white paper entitled *Implementation and Interpretation of Management Recommendations for the Northern Goshawk, Version 3.0* ("I&I" – USDA 2009) that calls for assessment of forest treatment effects to goshawk habitat at small clump- and group-scales, and not at the larger scale of a forest stand. This interpretation of guidelines for goshawk habitat in the amended forest plan shifts requirements for maintenance of canopy cover and vegetative structural stages from the stand scale to smaller scales. Its use in the current project requires an amendment to the forest plan.
Non-Significant Issue – The direction in the 1988 Kaibab Land and Resource Management Plan (as amended) supports the interpretation at the group level. The group can be addressed at multiple scales (e.g. site, landscapes, etc.).

17-8 The Center encourages the Forest Service to avoid creating forest openings larger than two (2) acres in the project. At a 2005 meeting with Forest Service biologists, Dr. Reynolds stated: "Do not create openings 4 acres in size unless there is an overriding management need, keep openings small." [4] Please refer to comments above for reasons why mistletoe treatments may not justify openings larger than forest plan guidelines allow.
Non-Significant Issue – The Proposed action would keep openings to less than 4 acres which is consistent with the direction in the 1988 Kaibab Land and Resource Management Plan (as amended).

17-9 Smoke accumulation from prescribed burning may flush owls from nests, causing incidental take. Therefore, the Forest Service is required to complete formal consultation with the U.S. Fish and Wildlife Service ("FWS") culminating in a biological opinion and incidental take statement to secure exemption of the proposed action from the Endangered Species Act's ("ESA") prohibition of take of listed species.
Non-Significant Issue – This issue will be resolved through routine analysis of the alternatives in the EIS. Consultation with the USFWS will be conducted in accordance with the Endangered Species Act.

17-10 Despite its admission of ongoing monitoring deficiencies, potential exceedance of incidental take, and non-compliance with the mandatory terms and conditions of the 2005 biological opinion, the Forest Service continues to approve site-specific projects that may affect Mexican spotted owl. The Forest Service is violating the mandatory terms and conditions set forth in the 2005 biological opinion concerning the implementation of the Forest Plans in the Southwest Region, including mandatory monitoring requirements for the Mexican spotted owl, in violation of the ESA. 16 U.S.C. § 1536(b)(4)(C)(iv); 50 C.F.R. §§ 402.14(i)(1)(iv), and 402.14(i)(3). Due to these monitoring failures, the Forest Service is also failing to insure that it has not exceeded the incidental take allowances for these species. Therefore, the agency should withhold approval of actions that may affect Mexican spotted owl pending reconsultation to insure that the proposed action will not irretrievably commit owls or their habitat.
Non-Significant Issue – This issue is outside the scope of the project. Consultation with the USFWS will be conducted in accordance with the Endangered Species Act.

17-11 The FS must disclose cumulative effects within the project area including timber sales, crown fires, past changes in forest structure, invasive plant populations, overall fire management goals for the project area, and the location of the project area in relation to important wildlife habitat.
Non-Significant Issue – This issue will be resolved through routine analysis of the alternatives and cumulative effects in the EIS.

17-12 If active grazing allotments overlap the planning area then we would be very concerned about potentially significant cumulative effects to soil, plant communities, fire regimes and wildlife forage that may result from active range management in combination with proposed treatments.
Non-Significant Issue – This issue will be resolved through routine analysis of the alternatives and cumulative effects in the EIS.

17-13 Treatments similar to the proposed action have left forest restoration sites overrun with cheatgrass (*Bromus tectorum*) (McGlone et al. 2009).
Non-Significant Issue – This issue will be resolved through routine analysis of the alternatives in the EIS and will be resolved by implementation of the "Design Features, Best Management Practices, and Mitigation Measures" identified in the "Final Environmental Impact Statement for Integrated Treatment of Noxious or Invasive Weeds on the Coconino, Kaibab, and Prescott National Forests within Coconino, Gila, Mojave, and Yavapai Counties, Arizona" (2004).

18-1 If fuels reduction is the main objective, a more strategic design and placement of evidence-based restoration treatments could more effectively protect values at risk, thereby reducing the need to treat the entire project area.
Non-Significant Issue – This issue will be resolved through routine analysis of alternatives in the EIS.

18-2 The Department does not think cable logging can be accomplished in an ecologically sound manner. We do not support the harvest of old growth trees if that is necessary for cable logging.
Significant Issue – This issue suggests an alternative with no cable logging systems.

18-3 The Department does not like the linear fuels control line arrangement as proposed.
Non-Significant Issue – This issue will be resolved through routine analysis of alternatives in the EIS.

18-4 The Department requests the FS to include a thorough description for old growth throughout the planning document. We recommend expanding the definition to include the essential structural features of old growth.
Non-Significant Issue – An analysis of old growth will be in the EIS and old growth will be described as it relates to the definition in the 1988 Kaibab Land and Resource Management Plan (as amended).

18-5 Be careful and strategic in the treatments of the relatively rare habitat types of Gambel oak and aspen.
Non-Significant Issue – The treatment of Gambel oak and aspen are addressed in the project proposal.

18-6 Ladder fuels should not be eliminated across large areas of the landscape as they are an important component of structural heterogeneity which is important to wildlife.
Non-Significant Issue – The proposed action does not include the elimination of all ladder fuels.

18-7 We encourage the FS to manage toward habitat diversity that includes greater variability in forest/meadow patch size, vertical heterogeneity, tree density, basal area and successional stage with an emphasis on old growth retention.
Non-Significant Issue – The proposed action does manage for diversity including through tree groups with dispersed openings and uneven-aged management.

18-8 We ask the FS to consider a wider range of BA within the desired conditions as 10-50 BA will not support many closed canopy animal species.
Significant Issue – This issue suggests an alternative with no Forest Plan amendments.

18-9 We ask that the FS place more emphasis on ensuring a mosaic of all successional stages, now and in the future, throughout a landscape comprised of all known habitat types. Please refer to our draft "Desired Ponderosa Pine Forest Conditions for Wildlife in the Southwest".
Non-Significant Issue – This issue will be resolved through routine analysis of alternatives in the EIS.

18-10 There is little information on the historic reference condition of mixed conifer. The Department recommends a smaller scale experimental approach to treatment in mixed conifer.
Non-Significant Issue – This issue will be resolved through routine analysis of alternatives in the EIS.

18-11 The Department is concerned about the similarity between wet and dry mixed conifer frequent fire DFC's. We don't want the FS to convert dry mixed conifer into PIPO when it's actually an important and distinct Potential Natural Vegetation Type.
Non-Significant Issue – This issue will be resolved through routine analysis of alternatives in the EIS. The proposed action does not include the conversion of cover types.

18-12 The dry mixed conifer type needs to be defined and mapped.
Non-Significant Issue – This issue will be resolved through routine analysis of alternatives in the EIS.

18-13 If the FS is going to continue with the dry mixed conifer concept, the Department recommends addressing the importance of retaining transitional, ecotonal habitats between ponderosa pine and mixed conifer for wildlife.
Non-Significant Issue – This issue will be resolved through routine analysis of alternatives in the EIS.

19-1 While the Sierra Club supports making wood derived from thinning treatments available to residents for personal use, we do not support large scale commercial extraction of timber from our National Forests. Please consider altering the Specific Need statement from "To provide forest products, such as firewood, for people living in Williams and the surrounding area, in order to meet their needs for forest and wood products, while protecting these resources for future generations" to "…in order to meet their *personal use* needs…" Also add to the "need for" list, Preventing erosion and soil loss that could further impair watersheds, Protecting rare, threatened and endangered species, and Protecting and enhancing wildlife habitat.
Non-Significant Issue – The purpose and need for action is appropriately scaled for the project based on management direction contained within the Forest Plan (which allows commercial timber harvest). The suggested needs are things that are also guided by management direction in the Forest Plan and Forest Service Handbooks and Manuals.

19-2 We encourage the Forest Service to focus this project on restoration of natural processes, such as fire, and restoring forest resiliency to help address the impacts of climate change and the historic impacts of fire suppression, logging, and livestock grazing.
Non-Significant Issue – This issue will be resolved through routine analysis of alternatives in the EIS.

19-3 The Sierra Club supports the use of fire to restore ecosystems, and finds this alternative preferable to mechanical treatments on steep slopes where mechanical treatment could lead to erosional problems and dangerous conditions. Helicopter treatments on 3,468 acres is not defensible and is an unnecessary expense for the KNF, a safety hazard, and a significant disturbance to wildlife and nearby residents.
Significant Issue – This issue suggests a burn only alternative and an alternative that does not utilize helicopter logging.

19-4 The Arizona Bugbane botanical area boundary should be respected. Treatments should protect the boundary, but mechanical treatment should not occur within the area because machines move across the ground too quickly for operators to observe details of vegetation composition. Skid trails in this area could also invite non-native invasive species.
Significant Issue – Mitigation measures have been developed to prevent and control the spread of non-native invasive species within the project area. This issue suggests an alternative that does not include mechanical treatments (except for hand-felling techniques) in the AZ bugbane botanical area.

19-5 The Strategic Fuels treatments should be considered in the context of restoring natural fire to the forest. Rather than creating artificial linear swaths, the Forest Service should focus on utilizing the natural features of the land, including the vegetative features for fuel breaks. This means using the using the existing heterogeneity and creating additional vertical breaks where necessary. This should be minimized in order to reintroduce natural fires. (Allen et al. 2002, Weatherspoon and Skinner 1996). The wide, relatively straight clearings running perpendicular to slopes proposed can cause soil loss and habitat fragmentation and if the goal is to continue fire exclusion, then the treatments will be counterproductive.
Significant Issue – Implementation of Soil and Watershed Best Management Practices (BMPs) would reduce the likelihood of erosion problems from construction of strategic fuels treatments.

19-6 The Forest Service should consider implementing fuel reduction first in areas where limited resource investment may be able to create more fire resilient stand conditions. This may include sites with little encroachment of small trees and open stands dominated by large conifers or hardwoods. Targeting initial work in these areas will maximize the area to be treated with available funds and personnel, and thereby provide the greatest opportunity to quickly reduce fuels and restore ecosystem function at larger spatial scales.
Non-Significant Issue – The proposed action includes strategic fuel treatments which will be implemented prior to any prescribed burning. Implementation of the project would begin in 2012 and would occur as funding and/or favorable conditions allow.

19-7 Larger, fire resistant trees should be left uncut.
Significant Issue - A mitigation measure has been developed to retain pre-settlement and old growth trees where possible. Some pre-settlement and old growth trees may be incidentally taken to allow harvesting activities to occur.

19-8 We agree with comments submitted by the Center for Biological Diversity and ask that the Forest Service develop and evaluate an alternative that would meet the purpose and need for action while conserving any presettlement and large trees outside of a well-defined wildland-urban interface - approximately ¼ mile from established community infrastructure.

Significant Issue - A mitigation measure has been developed to retain pre-settlement and old growth trees where possible. Some pre-settlement and old growth trees may be incidentally taken to allow harvesting activities to occur.

19-9 If there is riparian vegetation, wetland emergent vegetation, wetland or aquatic habitats in the treatment area, thinning activities should leave a buffer zone around these places that is sufficient to anchor soils and capture ash that may flow downhill after prescribed or naturally-occurring fires. This will protect water quality. Mechanical equipment should not be allowed to pass through these fragile, important habitats.
Non-Significant Issue – There are no riparian areas or wetland vegetation in the project area and implementation of the project will follow Forest Plan guidance and BMPs.

19-10 White fir germinates well in bare mineral soils, so burning will contribute to a new generation of white fir saplings. Frequent fire will be required to regularly re-treat and suppress white fir.
Non-Significant Issue – Maintenance burning is included in the proposed action.

19-11 Seeding the understory after treatments may help to inhibit non-native invasive species, and to shade white pine seeds, to prevent germination.
Non-Significant Issue – This issue will be resolved through routine analysis of the alternatives in the EIS and will be resolved by implementation of the "Design Features, Best Management Practices, and Mitigation Measures" identified in the "Final Environmental Impact Statement for Integrated Treatment of Noxious or Invasive Weeds on the Coconino, Kaibab, and Prescott National Forests within Coconino, Gila, Mojave, and Yavapai Counties, Arizona" (2004).

19-12 Keeping livestock grazing out of areas where white pine is undesirable might also be helpful, since a dense, healthy understory will suppress woody species germination.
Non-Significant Issue – The management of livestock grazing is outside the scope of this project.

19-13 Mechanical treatment near the base of the mountain only, and treatment exclusively with fire higher up on the mountain, is desirable.
Significant Issue – This issue suggests an alternative with limited mechanical treatments or a burn only alternative.

19-14 Presettlement and any and all old growth trees should not be cut. Large trees should not be cut to make room for regeneration. Conservation of large trees in fuel treatments is critical to restoration of fire-adapted forest ecosystems (Brown et al. 2004, DellaSala et al. 2004).
Significant Issue - A mitigation measure has been developed to retain pre-settlement and old growth trees where possible. Some pre-settlement and old growth trees may be incidentally taken to allow harvesting activities to occur.

19-15 Some shrubs should be left in the understory to provide forage, cover, and nesting sites for wildlife.
Non-Significant Issue – This issue will be resolved through routine analysis of alternatives in the EIS.

19-16 Some pockets of very high density forest should be left intact.
Non-Significant Issue – This issue will be resolved through routine analysis of alternatives in the EIS.

19-17 Understory seeding with a native seed mix should follow treatment, to suppress non-native invasive species, many of which increase fire risk on the landscape.

Non-Significant Issue – This issue will be resolved through routine analysis of the alternatives in the EIS and will be resolved by implementation of the "Design Features, Best Management Practices, and Mitigation Measures" identified in the "Final Environmental Impact Statement for Integrated Treatment of Noxious or Invasive Weeds on the Coconino, Kaibab, and Prescott National Forests within Coconino, Gila, Mojave, and Yavapai Counties, Arizona" (2004).

19-18 Impacts of livestock grazing should be considered as well. Livestock grazing contributes to the long term and degradation of grasslands contributes to the encroachment of noxious and invasive weeds as well as woody vegetation.
Non-Significant Issue – This issue will be resolved through routine analysis of the alternatives and cumulative effects in the EIS.

19-19 Spread of noxious weeds is a reasonably foreseeable and potentially significant forest-wide cumulative impact of the proposed action.
Non-Significant Issue – This issue will be resolved through routine analysis of the alternatives and cumulative effects in the EIS and will be resolved by implementation of the "Design Features, Best Management Practices, and Mitigation Measures" identified in the "Final Environmental Impact Statement for Integrated Treatment of Noxious or Invasive Weeds on the Coconino, Kaibab, and Prescott National Forests within Coconino, Gila, Mojave, and Yavapai Counties, Arizona" (2004).

19-20 Insects, diseases, and mistletoe are naturally part of the system (p.17). Once needles fall from dead trees, active crown fire risk in those stands may be reduced (Fleming et al. 2002, Romme et al. 2006, Jenkins et al. 2007). It is unclear what treatments are being proposed to deal with insects, disease, and mistletoe. Since snags and witches' brooms provide important habitat values, and mistletoe provides a drought-resistant food source for wildlife, the best treatment of these areas may be to burn them but not mechanical treatment.
Significant Issue - A mitigation measure has been developed to retain some dwarf mistletoe as a natural component in stands. This issue also suggests a burn only alternative.

19-21 Because of concerns about failure to monitor and inadequate monitoring and the potential for this project to result in an exceedance of incidental take relative to this species, we ask that the Forest Service refrain from actions that would affect the owls until the Forest Service has consulted with the U.S. Fish and Wildlife Service to ensure that this project would not result in significant harm to the owls and their habitat and exceedance of incidental take.
Non-Significant Issue – This issue is outside the scope of the project. Consultation with the USFWS will be conducted in accordance with the Endangered Species Act.

19-22 The Sierra Club can*not* support a one-time deviation from Forest Plan guidelines for Mexican spotted owls at this time. Please be explicit about the activities the KNF is seeking to undertake in these areas, how they deviate from current guidelines, why they are necessary, and how much habitat would be affected by the amendment.
Significant Issue – This issue suggests an alternative that does not amend the Forest Plan to deviate from Mexican Spotted Owl guidelines.

19-23 The Scoping Document is not specific about what deviations from these guidelines are needed, but the Sierra Club asks that the Forest Service consider the study by Beier and others (2008) that detected a negative correlation of goshawk breeding productivity with territories that were treated by logging consistent with the *MNRG* (Reynolds et al. 1992) and the amended forest plans and that populations of the northern goshawk are in decline across the forest. Please be explicit about the activities the KNF is seeking to undertake in these areas, how they deviate from current guidelines, why they are necessary, and how much habitat would be affected by the amendment.

Non-Significant Issue – This issue will be resolved through routine analysis of the alternatives in the EIS.

20-1 ADOT is concerned with the potential impacts with the existing forest road (947?) that parallels the Interstate 40 ROW with respect to potential higher year round use and any improvements, such as widening, increased drainage discharge to ADOT existing drainage structures, right-of-way fencing and smoke impacts to I-40.

Non-Significant Issue – This issue will be resolved through routine analysis of the alternatives and cumulative effects in the EIS.

(1)

STEVE PIERCE
MAJORITY WHIP
DISTRICT 1

1700 WEST WASHINGTON
ROOM 212, SENATE WING
PHOENIX, ARIZONA 85007-2844
TOLL FREE: 1-800-352-8404
CAPITOL PHONE: (602) 926-5994
CAPITOL FAX: (602) 417-3224
TOLL FREE FAX: 1-800-201-7545
spierce@azleg.gov

11/6 5/2/2011

Arizona State Senate

COMMITTEES:
NATURAL RESOURCES AND TRANSPORTATION
VICE CHAIR

RULES

April 29, 2011

Ms. Martie Schramm
Williams Ranger District
742 S. Clover Road
Williams, Arizona 86046

RE: Bill Williams Mountain Restoration Project

Dear Ms. Schramm:

I-1 I am in receipt of your letter dated April 26 regarding the Bill Williams Restoration Project. I heartily support this project and any efforts the Forest Service can do to improve the health of our forests.

Sincerely,

Steve Pierce
State Senator – District 1

SP/an

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Ms. Martie Schramm
Williams Ranger District
742 S. Clover Road
Williams, Arizona 86046

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Williams Ranger District
Kaibab National Forest

Senator Steve Pierce
1700 W. Washington
Phoenix, Arizona 85007

86046+3122

(2)

THE HOPI TRIBE

LeRoy N. Shingoitewa
CHAIRMAN

Herman G. Honanie
VICE-CHAIRMAN

May 5, 2011

Martie Schramm, District Ranger
Kaibab National Forest, Williams Ranger District
742 South Clover Road
Williams, Arizona 86046-9122

Re: Bill Williams Mountain Restoration Project

Dear Supervisor Williams,

This letter is in response to your correspondence dated April 26, 2011, regarding Kaibab National Forest proposing the 15,200 acre Bill Williams Mountain Restoration Project. The Hopi Tribe claims cultural affiliation to prehistoric cultural groups in Kaibab National Forest. The Hopi Cultural Preservation Office supports the identification and avoidance of prehistoric archaeological sites and we consider the prehistoric archaeological sites of our ancestors to be "footprints" and Traditional Cultural Properties. Bill Williams Mountain is a Traditional Cultural Property of the Hopi Tribe. The therefore, we appreciate Kaibab National Forest's continuing solicitation of our input and your efforts to address our concerns.

The Hopi Cultural Preservation Office routinely consults with Kaibab Forest Managers and Archaeologists during regular scheduled meetings on the Forests' Schedule of Proposed Actions. Therefore, we look forward to continuing consultations with the District and Forest on the development and implementation of cultural resources survey and Traditional Cultural Properties and ethnographic studies plans for this project. 2-1

If you have any questions or need additional information, please contact Terry Morgart at the Hopi Cultural Preservation Office at 928-734-3619 or tmorgart@hopi.nsn.us. Thank you for your consideration.

Respectfully,

Leigh J. Kuwanwisiwma, Director
Hopi Cultural Preservation Office

xc: Forest Supervisor, Mike Lyndon, Kaibab National Forest
Arizona State Historic Preservation Office

P.O. BOX 123 KYKOTSMOVI, AZ 86039 (928) 734-3000

(3)

James Benham
<jbenham83@yahoo.com>
05/10/2011 07:53 AM

To comments-southwestern-kaibab-williams@fs.fed.us
cc
bcc
Subject Bill Williams Mountain Restoration Project

Please find my comments in the attached PDF file.

-Jim Benham

Forest Service2.pdf

10 May 2011

Dear Forest Service,

My name is James Benham. I have an interest in the Benham Ranch south of Williams. I wholeheartedly support your objectives to reduce the risk of severe wildfire, promote forest health and to improve wildlife habitat on Bill Williams Mountain. I must also say that I have not had time to read the project proposal, so some of what I write about below may be covered elsewhere.

3-1 First, as you know there are lots of dead trees, both standing and fallen that should be removed. I suppose some must be left for animal habit. But simply removing most of this fuel should greatly reduce the fire danger. Besides the Mountain will look better! I had the trees thinned on my property in 2007 to help prevent crown fires and for healthier trees that remain. I assume the results on the Mountain will be similarly productive.

3-2 Some years ago (probably late 2005) there was a prescribed burn on Forest Service land north and west of my property. Since then I have noticed increased runoff and initially very dirty water containing lots of partially burned pine needles, among other things, flowing through my property. Am I correct in concluding that after a prescribed burn, more water runs off the land and therefore less soaks into the ground and is not available for the remaining trees and vegetation?

If you do a prescribed burn on the Mountain, will you be prepared for all the debris that will eventually flow down, including dirt and rocks? In other words, are you concerned about erosion and will you take steps to prevent it? Can the water treatment plant in Williams remove the debris and burned smell in the runoff?

3-3 There are many spots on the mountain that support unique plants. One that I know about is past the one mile marker on the Benham Trail. There is a stretch of several hundred feet of ferns. We have nicknamed it Ferndell. I would hope this area would not be subject to a prescribed burn.

3-4 Lastly, have you considered what will happen to the water quality of my well as a result of the proposed project? Many years ago some action caused the sediment load to increase greatly. Maybe it was when mining companies were looking for claims in the area. Anyway, it clogged my water filter within a day or two. I assume any disturbance on the land above my well is likely to cause additional dirt in my well water, but it would be nice to minimize it.

Thanks for considering my concerns. We all certainly enjoy a green and healthy Mountain and want to keep it that way. I am looking forward to seeing the results of your proposed project. Sincerely.

-James Benham

(4)

Bill Williams Mountain Restoration Project

Public Meeting Question and Answer Notes[1]

May 11, 2011

Q. On map 5, will the Bixler Saddle road be removed?

- Road will not be removed. However, it will be closed to motorized travel.
- Because the road will closed a part of the proposed action is to relocate the trailhead.
- Road will be used during implementation. When implementation is complete it will be a non-motorized trail.

4-1 Q. Any studies showing changes in chemistry of water supply?

- Not sure, but we will check with our soil scientist.
- A lot of research has been done following the Shultz fire that we will likely use to draw comparisons.

4-2 Q. Twin fire concerns – Can we do this project safely?

- Learned a lot from review.
- We have implemented those lessons.
- We are breaking burning into blocks.

4-3 Q. Is ponderosa pine valuable enough to do helicopter logging?

- Log cost analysis – under current market conditions it would be a deficit. We would have to get funding to pay for operations.

4-4 Q. Do mechanical thinning for first treatment then burn? – to help risk of fire getting out.

4-5 Q. Thinking in the short-term – campfire ban at base of peaks – consider ban on campfires around base of mountain.

Q. Any response/feelers on products coming out of this?

4-6 Q. Any chance of free use wood? (Identify areas?)

4-7 Q. Carefully attend to mixed conifer areas and wildlife areas.

4-8 Q. Concern about how much fuel is out there – looking for ways to help get the project done sooner rather than later.

[1] The answers from Forest Service personnel were not captured in their entirety or at all because per Paul Hancock, South Zone NEPA Coordinator, it was more important to capture the question/comment from the public. We will consider the questions/comments as we complete the analysis for the project.

4-9 Q. Any effort to leave pre-settlement trees? Old growth trees?

4-10 Q. Money for logging – What about FEMA?

4-11 Q. How easy will it be to sell the timber?

4-12 Q. Aspen restoration?

Q. Guessing 10 - 12 years for implementation?

Q. Funding through Homeland Security?

Q. How many acres went up in Flagstaff last year?

4-13 Q. Fuels are getting worse up there. I have been hiking up there for the past 32 years and am thankful the Forest Service is working on this project.

4-14 Q. Zone 1 – loggable now? Money would be positive? Plans to start process now or have to wait for whole thing to be approved?

- City Project

4-15 Q. Diameter cap limits?

4-16 Q. How are we going to keep the ash from coming down into the tanks (Benham area) from burning on the mountain when we burn?

4-17 Q. Map #2 – Erosion problems on fire lines straight down slopes or ridge lines?

4-18 Q. Would we be removing riparian vegetation or wetland vegetation?

4-19 Q. Map #5 – Maintenance level 1 roads will not be open to public. 64 ⟶ 29 miles?

- Map legends need to be corrected to show consistent measures (i.e. existing vs. open).

(6)

Williams Ranger District
Bill Williams Mountain Restoration Project

Public Comment Form

Please complete the information below and write-in your comments or concerns with the project. You may submit your comment form at any Kaibab N.F. office or by mail (this form is pre-addressed on the back; postage is required). **All comments must be submitted by May 23, 2011.**

Please Note: All comments and the names and addresses of those submitting them are added to the public record.

Name:	Susan Brown 928-699-3072	Address:	838 W. Fir Ave Williams, AZ 86046

Comments (attach additional sheets if necessary):

6-1 At the first Public meeting the City Water department folks were there to express their concerns with using prescribed fire to treat as the ash will go in the drainages when Runoff from monsoon snows occur and cause a major issue with our water System/Watershed.

Need to remember this as all your areas have a prescribed fire component.

Signed [signature] Date 5/11/11

Please fold on dotted lines and seal with TAPE (no staples please).

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Kaibab National Forest
Williams Ranger District
ATTN: Bill Williams Mountain Restoration Project
742 S. Clover Road
Williams AZ, 86046

(7)

Williams Ranger District
Bill Williams Mountain Restoration Project

Public Comment Form

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Please Note: All comments and the names and addresses of those submitting them are added to the public record.

Name:	Laura Duncan	Address:	601 S. 3rd Str Williams AZ

Comments (attach additional sheets if necessary):

7-1 Propose campfire ban (permanent) in project area, at least until this project is complete. Campfire ban Actually, better to expand area to use Rd 108 (Loop Road) as SW boundary because easier for public to understand, and Rd. 108 makes better fuel break.

Signed L Dun Date 5-11-11

(8)

Williams Ranger District
Bill Williams Mountain Restoration Project

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Name:	ROBYNN Eckel	Address:	2002 N. Airport Rd 86046

Comments (attach additional sheets if necessary):

Cleaning up dead wood and thinning (I under-
stand, makes common sense - yes! However
we love for that mountain [illegible] raised around
8-1 hike it, horseback it and picnic it. Please leave
some of it as wild as you. Because it amazing
what massive growths and intricacies [illegible] look like.
I love Bigfeet and so will be glad to see it un-
motorized. So, thank you. Is there any possible to
8-2 harvest baby trees, decorative wood (yard art) free before you
actually clear up the area (from [illegible], chain saws) and
then burn. Save what you can you know. Free use
gathering permits.

Signed ______________________ Date ____________

(9)

Williams Ranger District
Bill Williams Mountain Restoration Project

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Please Note: All comments and the names and addresses of those submitting them are added to the public record.

Name:	James Joseph	Address:	4150 st 11th Street Williams AZ 86046

Comments (attach additional sheets if necessary):

9-1 This to pretreatment conditions starting zones 1 and 2 and along S Perkinsville and RT 64. First

9-2 Mechanical thinning where feasable 1st. Might be more dollars up front but less chance of fire getting out of control. Be a prescribed after the mechanical so that it can be better control. Loggers could use the work - Rangeland products - environmentally stewardship.

9-3 Open up areas to firewood cutters. Probably not a big percentage of volume but would help. This would be a huge bonus to the locals and be a relational or community bonus point for the Forest Service

Signed [signature] Date 5-11-11

Please fold on dotted lines and seal with TAPE (no staples please).

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Kaibab National Forest
Williams Ranger District
ATTN: Bill Williams Mountain
Restoration Project
742 S. Clover Road
Williams AZ, 86046

(10)

Williams Ranger District
Bill Williams Mountain Restoration Project

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Please Note: All comments and the names and addresses of those submitting them are added to the public record.

Name:	Kali M. Kaliche	Address:	P.O. Box 23 Williams, Az 86046

Comments (attach additional sheets if necessary):

1) Thank you for taking the fire risk on Dusk Chaos seriously and providing a well thought out plan for bringing the mountain back to a safe, sustainable system. The proposal is not extreme. Being able to implement in pieces very appropriate

10-1 2) Please be careful on slopes & ravines to prevent run-off and erosion. Will you use berms, dams....? etc.

10-2 3) Areas of habitat for Spotted Owls, Goshawks, and Peregrine Falcons will need to be treated very carefully

10-3 4) Keeping a night-time patrol on prescribed burns seems to be a required precaution

5) The closing of old, poorly sited roads and replacing them with better engineered routes is a win-win proposal. Thank you

6) May $ be found to implement this proposal. May strong local support help encourage those funds.

10-4 7) How much of thinning can be made into stove pellets, kitty litter, or fine wood for local use and sales?

RECEIVED
MAY 12 2011
By

Signed Kali M. Kaliche Date 5/11/11

Please fold on dotted lines and seal with TAPE (no staples please).

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Kaibab National Forest
Williams Ranger District
ATTN: Bill Williams Mountain
Restoration Project
742 S. Clover Road
Williams AZ, 86046

(11)

Public Comment /Contact Form

Kaibab National Forest

DATE: May 12, 2011

TITLE OF DOCUMENT: Bill Williams Mountain Restoration Project

NAME: Kali Kalicka

ADDRESS:

PHONE:

E-MAIL:

COMMENTS: Appreciated meeting John Deluca at the public meeting.

11-1 Hopes wildlife gets the necessary attention, particularly bobcats, goshawks, peregrine falcons and Mexican Spotted Owls.

PHONE CALL X OFFICE VISIT ____ LOCATION:

RECORDED BY (NAME AND TITLE): Paul Hancock, NEPA Planner

SIGNATURE OF PERSON COMMENTING: NA left voice mail

(12)

Williams Ranger District
Bill Williams Mountain Restoration Project

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MAY 17 2011
By

Public Comment Form

Please complete the information below and write-in your comments or concerns with the project. You may submit your comment form at any Kaibab N.F. office or by mail (this form is pre-addressed on the back; postage is required). **All comments must be submitted by May 23, 2011.**

Please Note: All comments and the names and addresses of those submitting them are added to the public record.

Name:	Kali M. Kalicke	Address:	P.O. Box 23 Williams Az 86046

Comments (attach additional sheets if necessary):

12-1 An underlying problem in making Dusak Chama able to survive fire is the decades long downsizing of the U.S. Forest Service.

Consolidation of forests, privatizing of forest services, reductions in staffing, and loss of skilled & knowledgable employees means there are fewer trained observers on the ground.

This political agenda, though temporarily popular, is harmful to our public lands. Dedicated Forest Service personnel and local communities find their efforts ham-strung by this "anti-government", "conservative" trend.

I fear the consequences of under funding the U.S.F.S. will be dire.

Please send a copy of this letter to your Washington, D.C. bosses.

Signed Kali M. Kalicke Date 5/17/11

Please fold on dotted lines and seal with TAPE (no staples please).

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Kaibab National Forest
Williams Ranger District
ATTN: Bill Williams Mountain
Restoration Project
742 S. Clover Road
Williams AZ, 86046

(13)

Williams Ranger District
Bill Williams Mountain Restoration Project

Public Comment Form

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Please Note: All comments and the names and addresses of those submitting them are added to the public record.

Name:	David P. Mills	Address:	PO Box 61 Williams, AZ 86046

DAVIDPAUL MILLS @ GMAIL. COM

Comments (attach additional sheets if necessary):

Kudos to Martie Schramm, Tom Mutz and the ID team for their work in preparing the ground work for this long overdue project. Successful
13-1 implementation will reduce the threat of undesirable fire and lasting
13-2 damage to the city watershed, protect and restore wildlife habitat and maintain recreational opportunities. In addition to standard concerns
13-3 such as Goshawk and MSO habitat, T&E plants, invasive weeds, smoke
13-4 impacts to residents, cultural resources, etc., the project should:
13-5
13-6 – Restore and maintain healthy Aspen groves,
13-7 – Provide opportunities for fuelwood utilization (commercial and
13-8 personal) while minimizing expansion of unmaintained roads,
13-9
13-10 – Protect and promote the growth of Native American medicinal and ceremonial plants.

13-11 Treatments in lower elevation Ponderosa Pine forests should continue to aggressively thin and burn stands with the objective
13-12 to return to reference conditions. Maximum utilization of wood products is desirable.

13-13 Perhaps the greatest challenge will be the maintenance of mixed conifer stands while reducing potential for stand replacing fire such as are typical in that forest type.

13-14 Care will be required to balance hazard fuel reduction with other values and aesthetics.

Thanks!

Signed David P. Mills Date 5/20/2011

Please fold on dotted lines and seal with TAPE (no staples please).

Mills
PO Box 61
Williams AZ 86046

Kaibab National Forest
Williams Ranger District
ATTN: Bill Williams Mountain
Restoration Project
742 S. Clover Road
Williams AZ, 86046

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MAY 23 2011
Williams Ranger District
Kaibab National Forest

(14)

From: dark_55@q.com
To: comments-southwestern-kaibab-williamsmtn-fed.us

Subject: Scoping comments: the Bill Williams Mountain Restoration Project
Date: 05/22/2011 04:59 PM

May 22, 2011

Dear Mr. Mutz,

I thank you for giving me the opportunity to submit scoping comments for the proposed Bill Williams Mountain Restoration project.

Your proposed project concerns me.

Road Construction

The April 21, 2011 Federal Register indicates that road might be constructed for this project.

For decades the forest service has stressed to the public that temporary roads are ecosystem benign because they will be obliterated after use.

Please consider the following information:

14-1 Unless temporary roads are constructed on flat ground they have the potential to create more sediment per mile during precipitation events than system roads. I have seen this myself during monitoring trips to the field. This is because:

1) The earth must be handled twice .... when constructing the temporary road and when obliterating the road.
2) Temporary roads are "designed" by a logger on a cat with no knowledge of hydrology and the logger is under pressure to work quickly.
3) Most temporary roads are out-sloped, thus, the water on the road drains off the road at random places.
4) Temporary roads have no surfacing to slow the water velocity. High water velocity picks up more sediment particles.
5) Temporary roads have no ditch. Ditches adjacent to system roads control the water until the road designer calls for an appropriate outlet culvert location.

The science is clear. Sediment-laden water leaves the temp road at random locations . . . often in the streams.

Please read "Temporary Roads are Like Low Fat Ice Cream" by George Wuerthner , 3-17-09. The link to this article is at:
http://www.newwest.net/topic/article/temporary_roads_are_like_low_fat_ice_cream/C564/L564/

Please do not construct any roads (temp or system) for this sale. Of course there will be trees that cannot be harvested. This isn't as tragic as allowing harm to occur on public land so a corporation might increase profits.

Please seriously consider the following impacts to natural resources caused by road construction. If after analysis, it becomes apparent that any of the following impacts might occur (even with mitigation) I ask you to not construct roads.

- Roads decrease both the abundance and the richness of the macro-invertebrate soil fauna.
- Roads allow more human-caused fires to be ignited because they provide easier access.
- Roads compact soil which does not allow the water to seep into the road surface. This generates overland flow, and much of this flow often enters the stream channel system which increases peak flows.
- Forest roads involve slope-cuts and ditching that may intersect the water table and interrupt natural subsurface water movement.
- Roads alter animal behavior by causing changes in home ranges, movement, reproductive success, escape response, and physiological state.
- Roads change the microclimates by altering temperature and moisture regimes. Will such microclimate change be detrimental to the natural resources in the project area?
- Roads change the availability of cover and increase edge effect which adversely affects several small wildlife species.
- Roads bring together species that might otherwise not interact, potentially increasing rates of predation, competition and nest parasitism.
- Roads provide increased opportunities for exploitation by humans, such as:
  - poaching, overhunting, overfishing, and passive harassment of animals,
  - illegal collection for the pet trade,
  - increased trapping pressures, and
  - increased likelihood that snags and logs will be removed for fuel wood which is important habitat for some wildlife species.
- Animals avoid forest roads which leads to underutilization of habitats that are otherwise high quality. Are there any wildlife species in the project are that could be effected?
- Roads increase stream sedimentation and turbidity. Does the project area contain fish-bearing streams?

- Roads lead to slope failures, mass wasting and gully erosion.

- Road culverts act as barriers to movement for fish and other aquatic organisms, disrupting migration and reducing population viability. How many stream crossings will there be?

- Roads are a source of chemical pollutants that enter streams via runoff, such as salt, fuel and lead. This is poison to fish and any mammal (including humans) that might drink water down-stream.

- Roads are a **major** contributor to wildlife habitat fragmentation because they divide large landscapes into smaller patches and convert interior habitat into edge habitat.

- Roads become vectors for the dispersal of noxious weeds which harm wildlife when they eat the weeds.

- Roads lead to increased isolation of populations of species which cause adverse wildlife genetic effects; i.e. inbreeding depression (depressed fertility and fecundity, increased natal mortality) and decreased genetic diversity from genetic drift and bottlenecks.

14-2 It's very important to me that the proposed roads don't negatively affect wildlife in any way. Wildlife is my passion. I appreciate your efforts to reduce all impacts from road construction.

Timber Harvest

The April 21, 2011 Federal Register indicates that commercial timber harvest will occur.

Please consider each of the likely effects that are directly caused by timber harvest activities. If the Responsible Official plans to accept some of this resource harm please list the ham in the NEPA document and tell the public why the timber sale is important enough to accept such harm.

14-3 Science shows that timber harvest causes resource damage to occur. I have listed some below.

- Log landings and skid trails provide a source for sediment that might enter streams when it rains.

- Timber harvest removes dead and dying trees. When left on-site these trees decompose and create organic material in the soil. How will this organic material be replaced?

- Areas with the timber harvested are more susceptible to the outbreak of pests and regulate insect activity in surrounding homogenized forests (*Schowalter and Means*, 1989; *Franklin, Perry, Schowalter, Harmon, McKee and Spies*, 1989). Will this be true in this project area?

- Congress has found that tourists and forest visitors avoid areas where timber harvest has occurred. Statistics show that the economic stability of small communities near the forest is harmed. Congressional testimony shows that tourist dollars far exceed the revenue created by timber harvest activities. Will this be the case here?

- Adversely affects hydrologic processes by reducing canopy interception and evapotranspiration.

- Decreases the hydraulic conductivity and increases bulk density in forest soils after harvest.

- Increases water temperature by altering available sunlight, conductivity by changing the amount of organic matter that collects in vernal ponds, or pH if the logging process deposits foreign residues to the area. It also damages aquatic habitats through siltation and reduction in stream complexity.

- Removes organic material that harbor a myriad of organisms, from bacteria and actinomycetes to higher fungi.

- Removes mature and maturing trees which conserve essential elements, whereas the area containing new very young planted trees following logging are susceptible to erosion and essential element loss.

- Removes tree parts that would have created and maintained diversity in forest communities.

- Removal of dead and dying trees eliminates habitat required by bird species that feed on insects that attack living trees, with the result that outbreaks of pests may increase in size or frequency (Torgersen et al. 1990).

- Timber harvest collapses some of the subsurface pipes, increasing local pore water pressure and the chance of landslides (Sidle, 1986).

- Timber harvest diminishes recreational opportunities and harms visual quality.

Herbicides

14-4 If noxious weed treatment is planned I ask you not to use herbicides containing glyphosate.

The research of hundreds of independent, unbiased Ph.D. scientists not affiliated with the US Forest Service or Monsanto Inc. reveals that even casual contact with glyphosate-containing herbicides causes the following maladies in birds, fish, and mammals (including human visitors to the forest).

In the NEPA document please list the following effects of glyphosate-containing herbicide exposure. If the Responsible Official has recent science data showing the adverse health

effects are not true please include it in the NEPA document.

If no such data can be found please use other means to deal with noxious weeds and harmful nonnative vegetation.

- birth defects
- non-Hodgkin's lymphoma
- mitochondrial damage
- cell asphyxia
- miscarriages
- attention deficit disorder
- endocrine disruption
- DNA damage
- skin tumors
- thyroid damage
- hairy cell leukemia
- Parkinson disease
- premature births
- decrease in the sperm count
- harm to the immune system in fish
- death of liver cells
- severe reproductive system disruptions
- chromosomal damage

Thank you for your attention and time. I look forward to reading the draft NEPA document that responds to my concerns.

Sincerely,

Dick Artley
415 NE 2nd Street
Grangeville, Idaho 83530
dart_55@q.com
(208)-983-0181

(15)

Williams Ranger District
Bill Williams Mountain Restoration Project

To: Tom Mutz

RECEIVED
MAY 26 2011

Public Comment Form

Please complete the information below and write-in your comments or concerns with the project. You may submit your comment form at any Kaibab N.F. office or by mail (this form is pre-addressed on the back; postage is required). **All comments must be submitted by May 23, 2011.**

Please Note: All comments and the names and addresses of those submitting them are added to the public record.

Name:	Public Works/ WATER DEPARTMENT - CITY OF WILLIAMS	Address:	113 S. 1st STREET WILLIAMS, AZ 86046

Comments (attach additional sheets if necessary):

15-1 OUR CONCERN IS IF BILL WILLIAMS MOUNTAIN IS CONTROL BURNED, THE RUN-OFF IS KNOWN TO AFFECT THE WATER QUALITY IN THE SURROUNDING LAKES AND OUR ABILITY TO PROPERLY TREAT THIS WATER. THE FOREST SERVICE, OR QUALIFIED CONTRACTOR, WOULD NEED TO CONDUCT A STUDY ON THE EFFECTS OF THIS BURN ON THE WATER.

PLEASE SEE THE TWO ATTACHMENTS

CITY of WILLIAMS

Glenn Cornwell
Public Works Director

113 South First Street
Williams, AZ 86046-2549
gcornwell@williamsarizona.gov

928.635.4451 x 212
Cell 928.853.2823
Fax 928.635.4495

Signed G Glenn Cornwell Date 5-23-11

Please fold on dotted lines and seal with TAPE (no staples please).

Postage Required

Kaibab National Forest
Williams Ranger District
ATTN: Bill Williams Mountain
Restoration Project
742 S. Clover Road
Williams AZ, 86046

Background

Impacts of Wildfire on Water Quality

Water quality may be directly affected as a result of changed water balance, replacement of the forest litter by an ash/charcoal layer, and enhanced washoff of materials into streams. Washoff carries solids (charcoal, soil particles and clay) and dissolved materials (nutrients, dissolved organic matter) into streams and reservoirs. The extent to which washoff occurs in different catchments depends on their hydrological characteristics, and on the sequences of rainfalls that occur after the fire. Consequently, transfer of conclusions from one catchment to another is difficult, even though the same principles apply.

Washoff from burnt forests contains mineral clay particles that result in turbidity (cloudiness) as well as ash and a host of other constituents that alter the chemistry of water. These both independently affect water quality and also interact with aquatic biota in complex ways that can have highly variable effects on stream health. The significant changes to be expected in water quality are described below.

The impacts of wildfire on water quality in streams can be of shorter duration and quite different than in major water-supply reservoirs. If aquatic habitat in streams is changed as a result of fire (e.g. by massive sediment deposits), then stream water can also be affected in the long term. Here we outline some important impacts of fire on the quality of water in impoundments and other sources for water supply. Aquatic habitat and environmental flows are considered separately.

The Influence of Fire Intensity on Reservoir Water Quality

Low-intensity fires which do not burn the crown of the forest lead to leaf fall shortly after the fire. The first post-fire rains leach organic material out of these fallen leaves and deliver relatively large concentrations of dissolved organic matter (DOC) to the storage. In addition, large amounts of leaf litter may be delivered. In the stream, much of this organic matter is readily degraded microbially, with the concomitant consumption of oxygen. The resultant anoxia leads to elevated manganese concentrations, formation of reduced sulphur compounds with associated taste and odour problems, and water discolouration (so called "black water"). All these factors require additional treatment measures. The high DOC increases the chlorine demand in the water and, if chlorine is used as the disinfectant, much higher concentrations of trihalomethanes (THM) in the water, with consequent health risk. It is also possible that the water will contain relatively high concentrations of nitrate.

High intensity fires which burn most of the above-ground organic matter, or where fires occur on pasture land, lead to a different suite of water quality consequences. Most of the organic matter is removed in the fire through volatilisation. Much of the inorganic nutrients originally contained within the leaves or grass are leached out in the first post-fire rainfalls, and pass into the soil. Washoff of ash and fine soil particles delivers higher concentrations of phosphorus (but low concentrations of nitrogen) to the receiving waters. As a consequence, there will be a higher risk of blue-green algal blooms if the water enters the surface layer of a water storage reservoir. In agricultural areas, or where the degree of land disturbance is high, there can be severe local erosion and debris transport into streams exacerbating the problems noted above.

Key reference:

- Chessman, 1986
- Gresswell, 1999

Keywords:

fire	View Frequently Asked Questions	View Bibliography
nutrient	View Frequently Asked Questions	View Bibliography
water quality	View Frequently Asked Questions	View Bibliography

Influence of Town Water Source on Quality

Water supplies for towns are commonly withdrawn from weirs on streams with little if any significant storage, from sandbeds or aquifers adjacent to streams, or from reservoirs capable of holding a year or more's water supply. These may or may not incorporate filtration treatments before the water is piped to users. The impact of fire on water quality for these town water supplies will therefore depend on the degree of water treatment that is available, and the characteristics of water impoundments.

Quality of water from "Run of river" sources will suffer only in the short term, until the first flushes of contaminated streamflows pass by, although these impacts can be severe locally, particularly where the upstream disturbance is considerable, such as in agricultural areas. Little can be done to improve the quality of this water, except to remove large organic debris and increase the dosage of disinfectant (chlorination) to counteract the presence of higher levels of turbidity and organic matter. Water withdrawn from sandbed or other aquifers will probably suffer an undetectable decline in water quality.

Reservoirs fed directly by streams from burnt catchments, such as the Burrinjuck reservoir in NSW or the Corin and Bendora reservoirs in the ACT, may experience more severe water quality problems. Most storages deeper than about 10 metres are stably stratified. Consequently, moderate inflows of water enter the water column of the storage at a depth where their density is the same as the surrounding waters. Thus colder flows go to the bottom and warmer flows will skate across the surface. Flows which have a high DOC load which enter at intermediate depths are essentially cut off from supply of oxygen, so the resulting anoxia will be more pronounced than if the contaminated water enters at the surface. For nutrient laden waters from high intensity fire sites, the risk of algal blooms is diminished if the water enters deep within the storage. If it enters the surface layer the algal bloom risk is enhanced. Very large flows will cause complete overturn of water in the reservoir and mixing of the "new" and "old" waters.

The position of the layer of contaminated water within a storage should be established, and, if it is possible, the position of the water offtake changed to avoid taking the lower quality water into the drinking system. Storage managers need to be alert to the possibility of seiching within the storage leading to oscillation of the depth of the contaminated layer at the offtake. This leads to fluctuations in quality of the water being withdrawn, and makes smooth operation of treatment plants more difficult.

Keywords:

suspended sediment	View Frequently Asked Questions	View Bibliography
nutrient	View Frequently Asked Questions	View Bibliography
water quality	View Frequently Asked Questions	View Bibliography

Observations in Sydney water-supply catchments after fires 2002-2007

- Post-fire phosphorus concentrations (TP) were 7 times that of pre-fire loads in the Little River catchment, while post-fire nitrogen concentrations (TN) were only 1.6 times pre-fire concentration maximums. These elevated nutrient levels have returned to near pre-fire levels after five years.
- Post-fire total suspended solids (TSS) were up to 43 times that of pre-fire concentrations during major discharge events, but negligible at low flows.
- Post-fire sedimentation rates were one to two orders of magnitude above pre-fire levels and are now returning toward equilibrium as vegetation cover is re-established. It is also noted that the extreme severity of the wildfire in Little River catchment increased the proportion of surface erosion source from 10% pre-fire to 84% post-fire sediments. This surface erosion material also contained higher proportion of nutrients, as expected.
- The significance of post-fire water quality degradation was reduced owing to below average rainfalls in the years following the 2001 wildfire event.

See also Background section "Effects of Fire on Soils and Erosion"

Key reference:

- Chafer, 2007

- Preamble
- The Nature of Fire Disturbance in Forests
- Impacts of Wildfire on Water Flows from Forested Catchments
- Effects of Fire on Soils and Erosion
- Impacts of Wildfire on Water Quality
- Reducing Bushfire Impacts on Water Quality
- Implications for Aquatic Habitat and Environmental Flows
- Burning of Riverbank Vegetation Affects Aquatic Habitat
- Ecological Aspects of Stream Recovery after Bushfire
- Monitoring after Bushfires, 2002-2007
- Climatic Influences on Streamflow
- Influence of Bushfire on Future Forest Growth

The Bushfires and Catchments website is brought to you by the eWater CRC.

Water

Watershed Management Council

Fo[illegible]s on Hillslope Erosion: What We Know

Forest Fire Effects on Hillslope Erosion: What We Know

Peter R. Robichaud

USDA- Forest Service, Rocky Mountain Research Station, Moscow, Idaho

Introduction

Increased awareness of the role of fire in healthy ecosystems has focused attention on some of the effects of fires, wild and prescribed, on watershed condition and health. Precipitation events after forest fires may cause high sediment inputs, destruction of aquatic habitat and downstream flooding, all which may be part of the natural ecosystem response. However, if the fires are more severe due to past fire suppression activities, then the fire effects may be greater than natural. Fire and erosion are both natural processes that have been impacted by forest management activities such as fire suppression, logging, and road building during the last century. Management activities may contribute to increased streamflows and increased sediment supplies to streams and rivers. Additional sediment places streams and rivers at a higher risk for degradation. Sediment adversely affects spawning and rearing sites for anadromous and resident fish species, mobilizes in-stream sediment, and destroys aquatic habitat. Therefore, various management and mitigation strategies are often devised to reduce the threat of increased sediment. This paper reviews the effects of fire on hillslope erosion and the associated risks on watershed health.

Fire is a natural and important part of the disturbance regime for forested terrestrial and aquatic systems, especially in the western USA (Agee 1993). However, much uncertainty exists in quantifying fire effects on ecosystem components such as watershed condition and health.

Wildfires

Wildfires, which burn both small and large land areas, are often associated with lightning strikes from thunderstorms during the dry seasons and human-caused ignition (Agee 1990). Fire severity is a qualitative term used to measure the effect of fire on ecosystem components (Wahlstad et al. 1990) and is often used to describe fire effects on soil (Simard 1991). Ryan and Noste (1983) used ground char (burnt organic matter) classes to quantify fire severity. Fire effects on erosion are related to the effects of ground cover destroyed by fire. Ground cover usually consists of duff, grasses and debris on the ground surface. During fire, the consumption of ground cover (i.e. duff) exposes mineral soil which can be subject to overland flow and raindrop impact. The amount of vegetation, residue, and forest floor consumed and the soil heating caused by burning determines the extent to which soil properties are altered. The effects of fire on the forest floor can range from removing just the litter to total consumption of the forest floor and alteration of the mineral soil structure (Wells et al. 1979). The depth of the forest floor (litter layer and humus layer above mineral soil), the moisture content, and the amount of woody residue determine forest floor consumption during fire. When the forest floor is shallow or moisture content is low, fires consume more of the forest floor and have the potential to alter mineral soil (Reinhardt et al. 1991).

High severity burn areas experience higher rates of soil loss from erosion (McNabb and Swanson 1990), increased peak flows of runoff, greater duff reduction, loss in soil nutrients (Harvey et al. 1980), and soil heating (Hungerford et al. 1991). Water and sediment yields may increase as more of the forest floor is consumed (Robichaud and Waldrop 1994, Soto et al. 1994, Wells et al. 1979). If the organic layers are consumed and mineral soil is exposed, soil infiltration and water storage capacities are reduced (Robichaud 1996). Such impacts may last weeks or decades, depending on the fire' s severity and intensity, any remedial measures, and the rate of vegetative recovery (Baker 1990). Burning also reduces the amount of rainfall interception by the forest canopy and reduces evapotranspiration by the forest vegetation.

Prescribed Fires

The use of prescribed fire has increased tenfold over the last decade, as land managers are trying to restore fire suppressed landscapes. For example, logging residue is often burned after timber harvesting. Burning is used alone and in combination with other treatments to dispose of slash, reduce the risk of insects and fire hazard, prepare seedbeds, and suppress plant competition for both natural and artificial regeneration. The effect of prescribed burning on the forest floor varies greatly, depending on fire severity and duration, forest floor consumption, and soil heating.

Hillslope Erosion

Surface erosion is the movement of individual soil particles by a force, either by uniform removal of material from the soil surface (sheet erosion) or by concentrated removal of material in the downslope direction (rill erosion) or gravity inducted (dry ravel) or by mass movement as landslides and debris flows (Foster 1982). Inherent erosion hazards are defined as the site properties that influence erosion. They include the ease with which the individual soil particles are detached (soil erodibility), slope gradient and length. Forces required to initiate and sustain the movement of soil particles can be from many sources, such as raindrop impact (Farmer and Van Haveren 1971), overland flow (Meeuwig 1971), gravity, wind, and animal activity. Protection is provided by all material on or above the soil surface, such as vegetation, surface litter, duff, and rocks that reduce the impact of the applied forces (Megahan et al. 1986; McNabb and Swanson 1990).

Soils are critical to the functioning of hydrological processes. Within a watershed, sediment and water responses to wildfire are often a function of fire severity and the occurrence of hydrologic events. For a wide range of fire severities, the impacts on hydrology and sediment loss can be minimal in the absence of precipitation. However, when a precipitation event follows a large, high-severity fire, impacts can be substantial. Increased runoff, peak flows, and sediment delivery to streams can affect fish populations and their habitat (Binns 1997).

Fire can destroy the forest floor and vegetation, altering infiltration by exposing soils to raindrop impact or creating water repellent conditions (DeBano et al. 1998). Loss of soil from hillslopes produce several significant ecosystem impacts. Soil movement into streams, lakes, and riparian zones may degrade water quality and change the geomorphic and hydrologic characteristics of these systems and soil loss from hillslopes may alter future site productivity.

Water Repellency

Two types of water repellency are common in forest environments: the first occurs when the soils and organic material are very dry, and the second occurs when the soils are heated due to fires (Figure 1). Combustion of surface fuels and the forest floor vaporizes hydrophobic organic substances which may move downward and condense at cooler underlying soil layers (DeBano 1981; DeBano et al. 1998). Water repellency in the mineral soil can contribute to reduced infiltration of water into the soil and increased erosion (Robichaud 1996).

Figure 1: Water repellent soils below wettable soils after a high severity wildfire shortly after a summer thunderstorm

DeBano and Krammes (1966) and Robichaud and Hungerford (In press) found that water repellency was dependent on the heating temperatures. At typical wildfire soil profile temperatures (less than 500 F, 260 C) and when the soil was dry, water repellency occurs at shallow depths (less than 1 inch, 25 mm). With wet soils, i.e. conditions that commonly occur during prescribed fire in the spring and fall, water repellency was less pronounced and only occurred after long heating times which, under field conditions, would typically only occur during smoldering fires. Therefore, water repellency after prescribed fire would probably be minimal (Robichaud and Hungerford In press).

Infiltration and erodibility

We have used rainfall simulations and concentrated flow for the past decade to measure infiltration, interrill and rill erodibility and effects of various surface conditions. There are four hydrological surface conditions which are important to characterize hillslope erosion potential in forest environments. These are unburned/undisturbed areas, low severity burn areas, high severity burn areas and skid trails or other highly disturbed areas (Robichaud et al. 1993).

To obtain infiltration and interrill erodibility estimates, simulated rainfall is applied to 11 ft2 (1 m2) plots (Figure 2). Rainfall intensities usually were 4 in hr -1 (100 mm hr-1) for three 30-minute events. Timed bottled samples are collected at the base of the plots. The samples are weighed and dried for flow volumes and sediment yields. Infiltration and erodibility are then calculated. Values depend on surface conditions and inherent soil variability. For example, unburned infiltration rates vary from 1.4 to 3.1 inches hr-1 (35 to 80 mm hr-1), while high severity rates vary from 0.8 to 2.4 inches hr-1 (20 to 60 mm hr-1). Infiltration rates following high severity burns often increase with time, due to water repellent conditions breaking down (Robichaud In press).

Figure 2: Rainfall simulator used to obtain infiltration and interrill erodibility values on the Idaho Panhandle National Forest

Rill erodibility has been measured using concentrated flow down hillslopes (Robichaud and Brown 1999a) (Figure 3). Rill erosion is one of the dominant mechanisms of hillslope erosion. Various flow rates were used from 1.8 to 12 gal minutes-1 (7 to 45 l min-1) for 12 min with timed bottled samples used to collect runoff. These results were used to calculate sediment concentrations and rill erodibility. Sediment concentrations vary from 0.008 to 0.8 lb gal-1 (0.1 to 100 g l-1) which also vary according to surface condition and slope.

Figure 3: Concentrated flow being used to determine rill erodibility values on the Wenatchee National Forest

Spatial Variability

Fire severity is often variable, making erosion potential from burnt hillslopes also variable (Robichaud 1996). Spatial variability is an important characteristic of burned hillslopes. Geostatistical methods may be used to describe the spatial variability and topographic effects (Robichaud and Miller In

press). The importance of variability observed in the field has been verified with erosion prediction models examining various arrangements of high- and low-severity fires on a hillslope (Robichaud and Monroe 1997). For example, for a 100 m hillslope with ' low- above high-severity' burn and 'high- above low-severity' burn condition arrangement, the high-severity burn condition above the low-severity burn condition produced about 50 percent more sediment since the rilling initiated in the upper portions of the hillslope continued down throughout the lower portion. When two thirds of the upper portion of the hillslope is in high-severity burn conditions, it produced twice as much sediment as compared to when the upper two-thirds were in low-severity burn conditions. The arrangement of high-severity burn conditions above the low-severity burn condition on a hillslope is common. As a fire burns, the heat generated can dry-out the upper portions of a hillslope and cause it to burn more severely.

Water Yield

Total water yields across the western U.S. vary considerably depending on precipitation, evapotranspiration, soils, and vegetation. The magnitude of measured water yield increases the first year after fire. This magnitude can vary greatly within a location or between locations depending on fire severity, precipitation, geology, topography, vegetation, and proportion of the vegetation burned (DeBano et al. 1998). Increases in water yield are primarily due to elimination of plant cover, with subsequent reductions in the transpiration component of evapotranspiration (Anderson et al. 1976). Water repellent soils and cover loss will cause flood peaks to arrive faster, rise to higher levels, and entrain significantly greater amounts of bedload and suspended sediments. Elevated streamflows decline as both woody and herbaceous vegetation revegetate during a recovery period ranging from a few years to decades.

Increases in water yield from wildfires and prescribed fires are highly variable. The first-year increase in water yield after a prescribed burn in a Texas grassland was 1,150 percent of the unburned control watershed (Wright et al. 1982). In Arizona chaparral burned by wildfire, the first year water yield increase exceeded 1,400 percent mainly due to water repellent soils.

The effects of disturbance on storm peakflows are highly variable and complex. Wildfires generally increase peakflows. For example, the Tillamook burn in 1933 in Oregon increased the total annual flow of two watersheds by 9 percent and increased the annual peakflow by 45 percent (Anderson et al. 1976). A 310 ac (127 ha) wildfire in Arizona increased summer peakflows by 500 to 1,500 percent, but had no effect on winter peakflows (Anderson et al. 1976).

Sediment Yield

Fire-related sediment yields vary, depending on fire frequency, climate, vegetation, and geomorphic factors such as topography, geology, and soils (Swanson 1981). In some regions over 60 percent of the total landscape sediment production over the long-term is fire-related. Much of that sediment loss can occur the first year after a wildfire (Agee 1993, DeBano et al. 1998, DeBano et al. 1996, Robichaud and Brown 1999b). Suspended sediment concentrations in streamflow can increase due to the addition of ash and silt-to-clay sized soil particles in streamflow which can adversely affect fish and other aquatic organisms.

Sediment yields one year after prescribed burns and wildfires range from very low in flat terrain and in the absence of major rainfall events to extreme in steep terrain affected by high intensity thunderstorms (Figure 4). Erosion on burned areas typically declines in subsequent years as the site stabilizes, but the recovery rate varies depending on fire severity. Soil erosion after fires can vary from under 0.4 to 2.6 t ac-1 yr-1 (0.1 to 6 Mg ha-1 yr-1) in prescribed burns and 9 to over 49 t ac-1 yr-1 (21 to over 110 Mg ha-1 yr-1) in wildfires (Megahan and Molitor 1975; Noble and Lundeen 1971; Robichaud and Waldrop 1994; Robichaud and Brown 1999b). For example, Radek (1996) observed erosion of 0.1 to 0.8 t ac-1 (0.3 to 1.7 Mg ha-1) from several large wildfires that covered areas ranging from 375 to 4,370 ac (200 to 1,770 ha) in the northern Cascades mountains. Three years after these fire, large erosional events occurred from spring rainstorms, not from snowmelt. Robichaud and Brown (1999b) reported first year erosion rates after a wildfire from 9 to 22 t ac-1 (21 to 49 Mg ha-1) decreasing by one to two orders of magnitude by the second year and to no sediment by the fourth in an unmanaged forest stand in eastern Oregon. Erosion rate reduction was due to recovery of natural vegetation. First year growing season shrubs, forbs and grasses accounted for 28 percent of the total ground cover whereas after the second growing season, total ground cover was 82 percent.

Figure 4: Cleaning debris from a sediment trap at the base of hillslope on the Wenatchee National Forest

DeBano et al. (1996) demonstrated that following a wildfire in ponderosa pine, sediment yields from a low severity fire recovered to normal levels after three years, but moderate and severely burned watersheds took 7 and 14 years, respectively. Nearly all fires increase sediment yield, but wildfires in steep terrain produce the greatest amounts. Noble and Lundeen (1971) reported an average annual sediment production rate of 2.5 t ac-1 (5.7 Mg ha-1) from a 900 ac (365 ha) burn on steep river breaklands in the South Fork of the Salmon River, Idaho. This rate was approximately seven times greater than hillslope sediment yields from similar, unburned lands in the vicinity.

Potts et al. (1985) indicated that wildfires increased water yield and sedimentation. Post-burn sediment increases were severe only on sites with both steep slopes and large fires. They found maximum annual sediment production of 1.9 t ac-1 (4.3 Mg ha-1), an increase of 284 percent over natural yields. These estimates were based on large-scale regional estimates on metamorphic parent material.

Hillslope Erosion Modeling

The Water Erosion Prediction Project (WEPP) model can be used to predict hillslope erosion from disturbed forest environments (Elliot et al. 1999). The approach is to predict the probability of erosion occurring after a disturbance by running WEPP model for 50 to 100 years of stochastic climates. Thus, the results will emphasize the risk of various erosion events occurring immediately after a fire and in the following years, when revegetation has caused the area to be hydrologically recovered. Field data collected over the last ten years is being used to populate and validate our modeling efforts.

Summary

Hillslope erosion processes can dominate landscape shape, especially after wildfires. Rill erosion is often the dominant mechanism for delivering sediment to the base of the hillslopes. The often denuded landscapes allow for direct impact of precipitation events and overland flow. Sediment may adversely affect aquatic habitat and water quality. Since most of our land management activities have increased sediment loads to rivers and stream, any additional sediment due to the fires could likely be detrimental.

When analyzing hillslope erosion, especially after fire, we should remember that erosion potential is not equal everywhere, erosion will only occur if a precipitation or snowmelt event occurs, and annual sediment yields generally decrease rapidly as natural vegetation reestablishes itself. -

You can reach Pete at 208-883-2338/probl_rmrs_moscow@fs.fed.us

Literature Cited

Agee, James K. 1990. The historical role of fire in Pacific Northwest forests. In: Walstad, John D.; Radosevich, Steven R.; Sandberg, David V., eds. Natural and prescribed fire in Pacific Northwest forests. Corvallis, OR: Oregon State Univ. Press. chapter 3.

Agee, J.K. 1993. Fire ecology of Pacific northwest forests. Washington, DC: Island Press. 493 p.

Anderson, H.W., M.D. Hoover, and K.G. Reinhart. 1976. Forests and water: effects of forest management on floods, sedimentation, and water supply. Gen. Tech. Rep. PSW-18. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station.

Baker, M. B., Jr. 1990. Hydrologic and water quality effects of fire. In: Krammes, J. S., technical coordinator. Effects of fire management of Southwestern natural resources: Proceedings; Tucson, AZ. Gen. Tech. Rep. RM-191. Ft. Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 293 p.

DeBano, Leonard F. 1981. Water repellant soils: a state-of-the-art. Gen. Tech. Rep. PSW-46 Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station. 21 p.

DeBano, L. F. and Krammes, J. S. 1966. Water repellent soils and their relation to wildfire temperatures. Bulletin of the I.A.S.H., XI(2):14- 19.

DeBano, L.F., P.F. Ffolliott, and M.B. Baker, Jr. 1996. Fire severity effects on water resources. Pp. 77- 84. In: Ffolliott, P.F., L.F. DeBano, M.B. Baker, Jr., G.J. Gottfried, G. Solis-Garza, C.B. Edminster, D.G. Neary, L.S. Allen, and R.H. Hamre (tech. coordinators) Effects of Fire on Madrean Province Ecosystems<A Symposium Proceedings. Gen. Tech. Rep. RM-GTR-289. Ft. Collins: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 277 p.

DeBano, L.F., D.G. Neary, and P.F. Ffolliott. 1998. Fire' s Effects on Ecosystems. New York: John Wiley & Sons. 333 p.

Elliot, W.J. R. B. Foltz and P.R. Robichaud. 1999. Measuring and modeling soil erosion processes in forest. Presented at International Forestry Engineering Conference, Edinburgh, UK. 13 p.

Farmer, E. E.; Van Haveren, B. P. 1971. Soil erosion by overland flow and raindrop splash on three mountain soils. Gen. Tech. Rpt. INT-100. Odgen, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station. 14 p.

Foster, G. R. 1982. Modeling the erosion process. In: Haan, C. T.; Johnson, H. P.; Brakensiek, D. L., eds. Hydrologic modeling of small watersheds. St. Joseph, MI: American Society of Agricultural Engineers. chapter 8.

Harvey, A.E., M.F. Jurgensen, and R.T. Graham. 1989. Firesoil interactions governing site productivity in the Northern Rocky Mountains. In: D. Baumgartner, ed. Prescribed fire in the intermountain region: forest site preparation and range improvement. Pullman, WA: Washington State University: 9- 18.

Hungerford, R.D., M.G. Harrington, W.H. Frandsen, K.C. Ryan, and G.J. Niehoff. 1991. Influence of fire on factors that affect site productivity. In: F.I. Neuenschwander and A.E. Harvey, comps. Proceedingsmanagement and productivity of westernmontane forest soils. Gen. Tech. Rep. INT280. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station: 3250.

McNabb, David H. and Swanson, Frederick J. 1990. Chapter 14. Effects of fire on soil erosion. In: Natural and prescribed fire in Pacific Northwest forests. Walstad, John D., ed., et al. Corvallis, OR: Oregon State University Press, pp. 159- 176.

Meeuwig, Richard O. 1971. Soil stability on high-elevation rangeland in the Intermountain area. Res. Paper INT94. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station. 10 p.

Megahan Walter F.; Molitor, Delbert C. 1975. Erosional effects of wildfire and logging in Idaho. In: Watershed Management Symposium; 1975 August. Logan, UT: American Society of Civil Engineers Irrigation and Drainage Division: 423- 444.

Megahan, Walter F.; Seyedbagheri, Kathleen A.; Mosko, Timothy L., and Ketcheson, Gary L. 1986. Construction phase sediment budget for forest roads on granitic slopes in Idaho. In: Hadley, Richard F., ed. Drainage basin sediment delivery, proceedings. Albuquerque, NM: 1986. IAHS Publication 159. Wallingford, Oxon, UK. pp. 31- 39.

Noble, Edward L.; Lundeen, Lloyd. 1971. Analysis of rehabilitation treatment alternatives for sediment control. In: Symposium on forest land uses and stream environment: Proceedings; 1970 October; Corvallis, OR: Oregon State University: 86- 96.

Potts, Donald F. 1985. Water potential of forest duff and its possible relationship to regeneration success in the northern Rocky Mountains. Can. J. For. Res. 15:464- 468.

Radek, K.J. 1996. Soil erosion following wildfires on the Okanogan National Forest - initial monitoring results. In: International Erosion Control Association Symposium, February 27- March 1, 1996, Seattle, WA, 7 p.

Reinhardt, E.D., J.K. Brown, W.C. Fischer, and R.T. Graham. 1991. Woody fuel and duff consumption by prescribed fire in northern Idaho mixed conifer logging slash. Research Paper INT443. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station. 22 p.

Rinne, J.N. 1997. Shortterm effects of wildfire on fishes and aquatic macroinvertebrates in the southwestern United States. N. Am. J. Fish. Manage. 16:653- 658.

Robichaud, P. R. 1996. Spatially-varied erosion potential from harvested hillslopes after prescribed fire in the Interior Northwest. Ph.D. dissertation Moscow, ID: University of Idaho

Robichaud, P. R. [In press]. Fire effects on infiltration rates after prescribed fire in Northern Rocky Mountains. Journal of Hydrology.

Robichaud, P. R. and R. E. Brown. 1999a. Measuring rill erosion rates in a steep forest environment. Presented at the 1999 American Geophysical Union Spring Meeting, Boston, MA. 2 p.

Robichaud, P. R. and R. E. Brown. 1999b. What happened after the smoke cleared: onsite erosion rates after a wildfire in Eastern Oregon. Presented at the Wildland Hydrology Conference, Bozeman, MT. American Water Resources Assoc. 419- 426.

Robichaud, P. R. and S. M. Miller. Spatial interpolation and simulation of post-burn duff thickness after prescribed fire. [In press] International Journal of Wildland Fire.

Robichaud, P. R. and T. M. Monroe. 1997. Spatially varied erosion modeling using WEPP for timber harvested and burned hillslopes. Presented at 1997 Annual International Meeting, Paper No. 97-5015. ASAE, St. Joseph, MI. 8 p.

Robichaud, P.R. and T.A. Waldrop. 1994. A comparison of surface runoff and sediment yields from a low- and high-severity site preparation burns. Water Resources Bulletin 30 (1): 27- 34.

Robichaud, P. R. and R. D. Hungerford. [In press]. Water repellency by laboratory burning of four Northern Rocky Mountain forest soils. Journal of Hydrology.

Robichaud, P. R., C. H. Luce and R. E. Brown. 1993. Variation among different surface conditions in timber harvest sites in the Southern Appalachians. In International Workshop on Quantitative Assessment of Soil Erosion, Proceedings. Moscow, Russia. 231- 241.

Ryan, Kevin C. and Noste, Nonan V. 1983. Evaluating prescribed fires. Wilderness Fire Symposium; November 15-18; Missoula, Mont. 230- 238.

Simard, Albert J. 1991. Fire severity, changing scales, and how things hang together. Int. J. Wildland Fire 1(1):23- 34.

Soto, B.; Basanta, R.; Benito, E.; Perez R.; Diaz-Fierros, F. 1994. Runoff and erosion from burnt soils in northwest Spain. In: Sala, M.; Rubio, J. L., eds. Soil erosion and degradation as a consequence of forest fires: Proceedings; Barcelona Spain: 91- 98.

Swanson, F.J. 1981. Fire and geomorphic processes. Pp. 410- 420. In: Mooney, H. et al. (eds.) Proceedings of the Conference on Fire Regimes and Ecosystem Properties, Gen. Tech. Rep. WO-26. Washington, DC: US Department of Agriculture, Forest Service.

Walstad, John D.; Radosevich, Steven R.; Sandberg, David V. 1990b. Glossary. In: Walstad, John D.; Radosevich, Steven R.; Sandberg, David V., eds. Natural and prescribed fire in Pacific Northwest forests. Corvallis, OR: Oregon State University Press. appendix 3.

Wells, Carol G.; Campbell, Ralph E.; DeBano, Leonard F.; Lewis, Clifford E.; Fredriksen,

Richard L.; Franklin, E. Carlyle; Froelich, Ronald C., and Dunn, Paul H. Effects of fire on soil, a state-of-knowledge review. 1979. Gen. Tech. Rep. WO-7. Washington, DC: U.S. Department of Agriculture, Forest Service. 34 p.

Wright, H.A., F.M. Churchill, and W.C. Stevens. 1982. Soil loss and runoff on seeded vs. non-seeded watersheds following prescribed burning. Journal of Range Management 35:382- 385

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From: Letitia_Edgerson@fws.gov
To: comments-southwestern-kaibab-williams@ifs.fed.us
Cc: Vanessa_Sanchez@ios.doi.gov; Karen_Cathey@fws.gov; Denise_Rose@fws.gov; Martha_Hunkins@fws.gov; Stacey_Ruiz@fws.gov
Subject: Bill Williams Moutain Restoration Project Scoping Comment
Date: 05/23/2011 03:15 PM
Attachments: 048365 ER 11-351 Bill Williams_RestorationPjtcomments_clean.docx
048365 Signed ER 11-351 Bill Williams_Restoration Pjtcomments_clean.pdf

Mr. Mutz,

Attached is the U.S. Fish and Wildlife Service, Southwest Region, comments on the "Bill Williams Mountain Restoration Project, Williams Ranger District, Kaibab National Forest, Arizona".

Please call or reply if you have any questions or concerns.

Letitia Edgerson
Program Asst.
Southwest Region
Ecological Services
505-248-6643

United States Department of the Interior

U.S. FISH AND WILDLIFE SERVICE
Ecological Services
P.O. Box 1306, Room 6034
Albuquerque, New Mexico 87103

In Reply Refer To:
FWS/R2/ES-HC/EC/048365

May 23, 2011

Tom Mutz, Team Leader
Kaibab National Forest
Williams Ranger District
742 South Clover Road
Williams, Arizona 86046

Dear Mr. Mutz:

Thank you for your April 26, 2011, letter regarding the Bill Williams Mountain Restoration Project (Restoration Project) on the Williams Ranger District, Kaibab National Forest, Arizona. The U.S. Fish and Wildlife Service (FWS) has reviewed the April 21, 2011, Notice of Intent to Prepare an Environmental Impact Statement (76 FR 22363) and a scoping packet, dated April 2011. The comments provided below are intended to provide technical assistance toward the development of the proposed action and draft Environmental Impact Statement (DEIS). We offer comments based upon both the April 2011, scoping document and Federal Register Notice.

16-1 The scoping document indicates commercial logging and prescribed fire will occur throughout the project area. In addition, the project description suggests the overall goal is fuels reduction, as opposed to forest restoration. We agree with the purpose and need for the Restoration Project, and we believe the restoration objective, coupled with protection for the city of Williams, Arizona, can be accomplished while retaining the structural integrity of Mexican spotted owl (MSO) habitat, as described in the MSO Recovery Plan. Given the project description, we recommend a strategic treatment design be incorporated into the proposed action to retain and maintain structural integrity of forest habitat. For example, key placement of fewer targeted treatments along with a prescribed burning plan would be effective in achieving Restoration Project goals. This strategic treatment is likely to retain and maintain habitat for listed species, including the MSO, special status species, and other wildlife and plants.

16-2 On January 19, 2011, FWS biologists met with U.S. Forest Service (USFS) biologists to discuss aspect (south facing slopes), which should further assist the USFS in identifying areas for thinning. Incorporation of previous treatments and recommendations in the overall plan should assist placement of thinning treatments. Therefore, we recommend the Restoration Project consider treatments previously implemented in the project area and its vicinity. We also recommend the
16-3 Restoration Project include recommendations developed from the recent Forest Health Focus effort.

16-4 The scoping document does not mention if an MSO Protected Activity Center (PAC) occurs within the project area. We recommend the DEIS disclose if a PAC exists within the project area and any effects from the Restoration Project to the PAC be considered and addressed. We encourage the Restoration Project to enhance and protect MSO habitat within a PAC, as recommended in the MSO Recovery Plan.

16-5 The scoping document refers to a ponderosa pine cover type. A portion of the cover type pine-oak, is MSO habitat. We recommend you work with FWS to identify MSO pine-oak habitat to ensure treatments developed in this habitat will benefit the MSO and assist the USFS in restoration of the
16-6 area. Similarly, the MSO Recovery Plan refers to a mixed conifer cover type, but also refers to Douglas-fir and white fir cover types. To assist the USFS in identifying MSO habitat and potential treatments, we recommend describing the project area in terms of mixed conifer cover type as defined in the MSO Recovery Plan.

The ponderosa pine and mixed conifer desired condition sections appear to confuse the discussion of MSO protected habitat with target/threshold habitat. These are different categories of MSO habitat
16-7 and each has their own management guidelines as described in the MSO Recovery Plan. We recommend including MSO protected and restricted habitat as a discussion in this section to avoid
16-8 confusion. This section also confounds MSO guidelines and northern goshawk guidelines. Northern goshawk guidelines are also presented as desired conditions for mixed conifer (particularly within MSO protected and target/threshold habitat) with no reference to guidelines described in the MSO Recovery Plan. We encourage the USFS to refer to the MSO Recovery Plan management recommendations (Volume I/Part III; pp.82-96), and primary constituent elements found in the final rule designating MSO critical habitat (August 31, 2004; 69 FR 53232).

The specific stated desired conditions may not result in maintenance of MSO habitat. For example, the stated desired condition includes open stands (approximately 10 to 50 trees per acre or 10 to 50 square feet of basal area per acre) with groups of ponderosa pine surrounded by 30 to 80 percent open interspaces with scattered individual trees. It is unclear where this condition type would be created, and if it is applied to restricted MSO habitat in the pine-oak cover type, it is not likely to
16-9 provide MSO habitat. We recommend the USFS follow the management guidelines recommendations for each category of MSO habitat (PAC, protected steep slope, target/threshold, and restricted) and critical habitat as described in the MSO Recovery Plan and the final rule designating critical habitat.

16-10 In the scoping document, the section on desired conditions for ponderosa pine and mixed conifer cover types suggests the desired conditions are driven by management guidelines for the northern goshawk. However, in areas where the guidelines conflict with MSO Recovery Plan recommendations in MSO habitat (pine-oak and mixed conifer), we encourage the MSO Recovery Plan recommendations take precedence.

16-11 A desired condition for both ponderosa pine and mixed conifer cover types states large trees of all species will be developed throughout the cover type. The pine-oak and mixed conifer cover types likely contain many large trees, a key habitat component of MSO habitat and a primary constituent element of MSO critical habitat. We recommend the proposed action be designed to maintain this key habitat component and primary constituent element.

16-12 A desired condition for both ponderosa pine and mixed conifer cover types states fuel loading will average 5 to 7 tons per acre in northern goshawk habitat in those cover types. We recommend the Restoration Project be designed to retain a sufficient amount of large logs and other dead and down material compatible with MSO needs and primary constituent elements of MSO critical habitat, while meeting forest restoration objectives. We also recommend the USFS refer to Brown et al. (2003) and Graham et al. (2004) regarding the amount of coarse woody debris needed to maintain soil health in ponderosa and mixed conifer forests in northern Arizona.

16-13 The scoping document states sites with dwarf mistletoe left unmanaged in the area cannot be maintained in a sustainable, uneven-aged condition. We understand there is a need to manage dwarf mistletoe as part of forest restoration objectives, and we recommend including an objective to support uneven-aged management in dwarf mistletoe-infected stands.

16-14 The Arizona bugbane is a sensitive species for which a conservation strategy and agreement was developed. Additional measures may be needed to protect this species during implementation of the Restoration Project. We encourage the USFS to implement the terms of the conservation strategy and agreement as part of the proposed action.

16-15 The State of Arizona and various American Indian Tribes maintain lists of sensitive species that may not be protected by Federal law. We recommend you contact the Arizona Game and Fish Department (AGFD) and any affected tribe to determine if sensitive species may occur in the action area. We encourage the USFS to invite the AGFD and any affected tribe to participate in the review of your proposed action.

We recommend the following specific items for inclusion in the proposed action:

16-16 1. Maintain mixed conifer habitat and avoid removing important components (white fir, Douglas-fir, and other mixed conifer tree species);

16-17 2. Maintain pre-settlement/old-growth trees;

16-18 3. Maintain pine-oak habitat within MSO PACs; and,

16-19 4. Maintain mixed conifer stands containing aspen as mixed conifer habitat described in the MSO Recovery Plan.

We appreciate this opportunity to provide comments on the Restoration Project, and we look forward to continuing our work with the USFS in developing the proposed action and DEIS. If you have any further questions, please contact Steve Spangle, Field Supervisor, Ecological Services Field Office, Phoenix, Arizona, at 602-242-0210, extension 244.

Sincerely,

/s/ Nicholas Chavez

Acting Regional Director

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We recommend the following specific items for inclusion in the proposed action:

1. Maintain mixed conifer habitat and avoid removing important components (white fir, Douglas-fir, and other mixed conifer tree species);

2. Maintain pre-settlement/old-growth trees;

3. Maintain pine-oak habitat within MSO PACs; and,

4. Maintain mixed conifer stands containing aspen as mixed conifer habitat described in the MSO Recovery Plan.

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Sincerely,

Acting Regional Director

cc: Forest Supervisor, Kaibab National Forest, Williams, AZ
Director, Aha Makav Cultural Society, Fort Mojave Indian Tribe, Mohave Valley, AZ
Tribal Secretary, Havasupai Tribe, Supai, AZ
Director, Hopi Cultural Preservation Office, Kykotsmovi, AZ
Program Manager, Tribal Historic Preservation Office, Hualapai Tribe, Peach Springs, AZ
Director, Historic Preservation Department, Navajo Nation, Window Rock, AZ
Director, Apache Cultural Program, Yavapai-Apache Nation, Camp Verde, AZ
Director, Yavapai Cultural Program, Yavapai-Apache Nation, Camp Verde, AZ
Director, Cultural Research Program, Yavapai-Prescott Indian Tribe, Prescott, AZ
Director, Zuni Heritage and Historic Preservation Office, Zuni, NM
Environmental Specialist, Environmental Services, Western Regional Office, Bureau of Indian Affairs, Phoenix, AZ
Office of Environmental Policy and Compliance, Regional Environmental Officer, Oakland, CA, Attention: Patricia Port
Office of Environmental Policy and Compliance, (Attention: Lisa Chetnick Treichel;
Assistant Field Supervisor, Fish and Wildlife Service, Flagstaff, AZ (Attention: Shaula Hedwall
Chief, Habitat Branch, Arizona Game and Fish Department, Phoenix, AZ
Andi Rogers, Arizona Game and Fish Department, Flagstaff, AZ
Director (AFHC-HRC), Attention: Stephanie Nash

cc: Forest Supervisor, Kaibab National Forest, Williams, AZ
Director, Aha Makav Cultural Society, Fort Mojave Indian Tribe, Mohave Valley, AZ
Tribal Secretary, Havasupai Tribe, Supai, AZ
Director, Hopi Cultural Preservation Office, Kykotsmovi, AZ
Program Manager, Tribal Historic Preservation Office, Hualapai Tribe, Peach Springs, AZ
Director, Historic Preservation Department, Navajo Nation, Window Rock, AZ
Director, Apache Cultural Program, Yavapai-Apache Nation, Camp Verde, AZ
Director, Yavapai Cultural Program, Yavapai-Apache Nation, Camp Verde, AZ
Director, Cultural Research Program, Yavapai-Prescott Indian Tribe, Prescott, AZ
Director, Zuni Heritage and Historic Preservation Office, Zuni, NM
Environmental Specialist, Environmental Services, Western Regional
Office, Bureau of Indian Affairs, Phoenix, AZ
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Andi Rogers, Arizona Game and Fish Department, Flagstaff, AZ
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Literature Cited

Brown, J.K., E.D. Reinhardt, and K.A. Kramer. 2003. Coarse woody debris: managing benefits and fire hazard in the recovering forest. Gen. Tech. Rep. RMRS-GTR-105. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 16 pp.

Graham, R.T., A.E. Harvey, M.F. Jurgensen, T.B. Jain, J.R. Tonn, and D.S. Page-Dumroese. 1994. Managing coarse woody debris in forests of the Rocky Mountains. Research Paper INT-RP-477, Ogden, UT. U.S. Department of Agriculture, Forest Service, Intermountain Research Station. 16 pp.

United States Department of the Interior

U.S. FISH AND WILDLIFE SERVICE
Ecological Services
P.O. Box 1306, Room 6034
Albuquerque, New Mexico 87103

In Reply Refer To:
FWS/R2/ES-HC/EC/048365

MAY 2 3 2011

Tom Mutz, Team Leader
Kaibab National Forest
Williams Ranger District
742 South Clover Road
Williams, Arizona 86046

Dear Mr. Mutz:

Thank you for your April 26, 2011, letter regarding the Bill Williams Mountain Restoration Project (Restoration Project) on the Williams Ranger District, Kaibab National Forest, Arizona. The U.S. Fish and Wildlife Service (FWS) has reviewed the April 21, 2011, Notice of Intent to Prepare an Environmental Impact Statement (76 FR 22363) and a scoping packet, dated April 2011. The comments provided below are intended to provide technical assistance toward the development of the proposed action and draft Environmental Impact Statement (DEIS). We offer comments based upon both the April 2011, scoping document and Federal Register Notice.

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(17)

From: Jay Lininger
To: comments-southwestern-kaibab-williams@fs.fed.us
Subject: Bill Williams Mountain Restoration Project scoping comment
Date: 05/23/2011 10:06 PM
Attachments: AGFD_Rpt2_Cmen_Brief_072707.pdf
Beier_et.al_2007_NOGD.pdf
SO_2006_02_28_#_m_Beier_Papers.pdf
image001.png
image003.png
image005.png

Hard copies of the letter pasted below and attachments will follow in U.S. Mail.

May 23, 2011

Tom Mutz, Team Leader
Williams Ranger District
742 S. Clover Road
Williams, AZ 86046
Email: comments-southwestern-kaibab-williams@fs.fed.us

RE: Bill Williams Mountain Restoration Project

This letter supplies comment from the Center for Biological Diversity ("Center") responding to the notice of intent to prepare an environmental impact statement for the Bill Williams Mountain Restoration Project (76 Fed. Reg. 22363, April 21, 2011). The Center is a non-profit conservation organization with more than 312,000 members and online activists, many of whom live in Arizona, with long-standing interests in management of the Kaibab National Forest. Thank you for soliciting input.

The Center strongly supports Forest Service efforts to manage hazardous fuels and restore adapted ecological functions of ponderosa pine and mixed conifer forest in the project area. In particular, we recognize utility in strategically placed fuel treatments to facilitate landscape-scale restoration of fire disturbance processes (Finney 2001). Fire use is indispensable to forest restoration (Falk et al. 2006). Ongoing climate change ensures that wildland fires will become larger and more frequent at a landscape scale (Westerling et al. 2006). In the absence of fire use on relatively short rotations compared to the era of total fire suppression, the Forest Service effectively manages the landscape for large scale, high intensity fires during extreme weather, necessitating unnecessary taxpayer expense and unacceptable risk to human life and resource values.

Alternatives

Informed consideration of action alternatives is the "heart" of the National Environmental Policy Act because it allows sharp definition of relevant issues for environmental analysis and provides a clear basis for choice among options by the decision maker and the public. 40 C.F.R. § 1502.14. The Forest Service is required to "[r]igorously explore and objectively evaluate all reasonable alternatives." *Id.* § 1502.14(a); 42 U.S.C. § 4332(2)(E) (agencies required to "study, develop, and describe appropriate alternatives to recommended courses of action in any proposal which involves unresolved conflicts concerning alternative uses of available resources").

17-1 Landscape-scale assessment of ecological conditions and wood supply in ponderosa pine forests on the Mogollon Rim identified a "zone of agreement" within which vegetation treatments are likely to proceed on public lands without significant debate (Hampton et al. 2008). The Center requests that the Forest Service study, develop, and describe an alternative that would meet the purpose and need for action while conserving trees larger than 16-inches diameter at breast height ("dbh") outside of a well-defined wildland-urban interface ("WUI") zone comprising one-quarter (¼) mile distance from established residential and other community infrastructure. The proposed WUI in this alternative is twice as large as the "intensive" treatment zone described in the 1997 Williams/Chandler WUI Assessment. Outside the WUI, the project should conserve large trees in order to provide for wildlife habitat, old-growth recruitment, fire resilience, and general aesthetics. A size threshold of 16-inches dbh consistently defines "large" trees in the literature on southwestern ponderosa pine forests (Abella et al. 2006, Friederici 2003). Large trees are extremely rare at a landscape scale. Trees larger than 16" dbh comprise approximately three percent (3%) of live ponderosa pines in Arizona and New Mexico, according to Forest Inventory and Analysis (FIA) data (USDA 2007, 1999). More than eighty-two percent (82%) of ponderosa pine trees in the region are smaller than 11" dbh; approximately ninety-six percent (96%) of ponderosa pines are smaller than 15" dbh; and less than one-tenth of one percent (.01%) are larger than 21" dbh (Table 1). Clearly, the size distribution of trees in fire-suppressed conifer forests is heavily skewed toward small-diameter trees, and is dramatically different than historical conditions (Fulé et al. 1997).

Table 1. Tree size class distribution in southwestern ponderosa pine forests.

Size class	Distribution
< 11 inches dbh	82%
< 15 inches dbh	96%
> 16 inches dbh	3%
>21 inches dbh	0.1%

Source: Forest Inventory and Analysis National Program
Forest Inventory Data Online (FIDO). http://www.fia.fs.fed.us/tools-data/

Past timber harvest destroyed nearly all ponderosa pine and mixed conifer old growth forests throughout Arizona and New Mexico, including on most of the Kaibab National Forest, where regeneration silviculture and fire exclusion established even-aged forest divested of structural diversity and adapted ecological functions (Covington and Moore 1994, Sesnie and Bailey 2003). Old growth forests differ functionally from younger forests in the habitat they offer to wildlife, carbon storage, water filtration and flow regulation, and nutrient cycling (Kaufmann et al. 1992).

A precautionary approach to large tree conservation in silvicultural management is warranted in site-specific projects because a variety of factors other than logging threaten the remaining large trees in southwestern forests. Prescribed fire treatments can damage tree roots and cause high levels of mortality among large trees (Sackett et al. 1996). Burning of pine stands with high surface fuel loading also can result in tree mortality (Hunter 2007), and fire treatments may leave trees susceptible to bark beetle infestation (Wallin et al. 2003). In addition, large tree mortality has unintentionally resulted from mechanical thinning projects (Hunter 2007). Large snags and downed logs, which provide critical habitat for cavity-nesting birds, bats, small mammals, reptiles, amphibians and insects, are often destroyed by fuel reduction treatments (Hunter 2007). Any gains in new snags and downed logs as a result of vegetation treatments do not offset their loss at a landscape scale (Randall-Parker and Miller 2002). Therefore, the persistence of large trees and snags and restoration of old growth forest functions is by no means assured. Considering their scarcity, as well as the unique services they provide, large trees should be preserved whenever possible.

McHugh and Kolb (2003) describe unplanned and

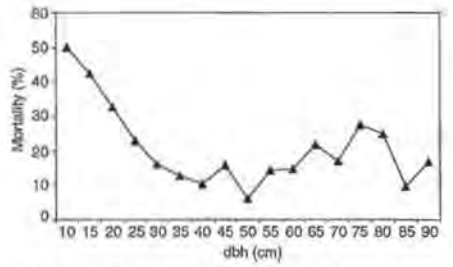

Fig. 3. Observed percent mortality of ponderosa pine 3 years after fire by 5 cm dbh class for data combined over three fires in northern Arizona. Data are not shown for dbh classes with <3 trees.

prescribed fire effects on ponderosa pine forest structure in northern Arizona. They describe a "U-shaped" tree mortality curve in which mortality was lowest among trees sized 30 – 60 centimeters ("cm") (approx. 12" – 24") dbh, and highest among the smallest trees as well as in the 75 – 80 cm (~29.5" – 31.5") dbh. Resistance to fire-induced mortality was greatest among trees sized 35 – 75 cm dbh. Mortality effects occurred despite relatively uniform "crown damage" across tree size classes, indicating that cambial injury and root scorch fire effects were most significant among the smallest and largest trees, whereas intermediate-sized trees were relatively uninjured and may have benefited from the disturbance (McHugh and Kolb 2003 – see Figure 3). The large tree conservation alternative would best maintain trees that are most likely to survive fire injury and supply recruitment structure that will support deficient old growth forest structure in the future.

Conservation of large trees in fuel treatments is fundamentally important to restoration of fire-adapted forest ecosystems (Brown et al. 2004, DellaSala et al. 2004). Large and/or mature ponderosa pine trees possess autecological characteristics such as relatively thick bark and insulated buds that promote resistance to heat injury (Weaver 1951). In addition, self-pruning mature ponderosa pines feature high branch structure and open canopies, which discourage torching (Keeley and Zedler 1998). More, mature ponderosa pines have a high capacity to survive and recover from crown scorch (McCune 1988). Thus, the existence of large tree structure enhances ecosystem fire resilience, particularly where fire effects to vegetation and soil are relatively severe (Arno 2000, Pollett and Omi 2002).

Large trees are the most difficult of all elements of forest structure to replace once they are removed (Agee and Skinner 2005). Further, large trees are not particularly abundant at any spatial scale in the Southwestern Region. The ecological significance of old growth forest and large trees comprising their structure at stand- and landscape-scales is amply documented, whereas a scientific basis for logging large trees for purposes of fuel reduction or forest restoration is lacking (Allen et al. 2002, Friederici 2003). Large tree removal is not necessary or beneficial to fire hazard reduction or restoration in ponderosa pine forests (Falk et al. 2006, Fiedler and Keegan 2002, Perry et al. 2004), but their conservation is centrally important to meet the purpose and need for action (Brown et al. 2004, DellaSala et al. 2004).

Because large trees are the most difficult of all forest structural elements to replace, logging them may constitutes an irreversible environmental impact that is scientifically controversial in regards to its efficacy in fire hazard reduction and forest restoration (Naficy et al. 2010, Williams et al. 2010). Therefore, large tree removal should be a significant issue in the forthcoming environmental impact statement to account for potentially significant impacts to forest vegetation, old growth recruitment, and wildlife habitat. *See* 40 C.F.R. § 1508.27.

17-2

Fuel treatments

A distinguishing feature of ecologically resilient conifer forests is a prevalence of large trees that survived numerous fires or possess autecological characteristics that predispose them to survival through fire disturbance, such as bark thickness and crown base height (Arno 2000). Forests containing large trees also tend to feature structural characteristics in the form of high canopies and large down logs that may inhibit intense fire behavior in most weather conditions (Graham et al. 2004). Large downed logs can slow sub-canopy horizontal wind movement and fire spread (Countryman 1956), and they often store huge quantities water that deprives fire of heat energy, even when their outer shells are completely dry (Amaranthus et al. 1989). Removal of large woody structure can diminish ecosystem resiliency to fire (Agee and Skinner 2005, Brown et al. 2004, Omi and Martinson 2004).

The intensity of fire behavior and the severity of its physical and biological effects partly depend on fuel properties and their spatial arrangement. Fuel bed structure plays a key role in fire ignition and spread potential, and it is central to developing an effective fuel management strategy (Graham et al. 2004). The bulk density (weight within a given volume) of surface fuels consisting of grasses, shrubs, litter and dead woody material in contact with the ground influences frontal surface fire behavior (heat output and spread rate) more than fuel load (weight per unit area) (Agee 1996, Sandberg et al. 2001). High surface fireline intensity increases the likelihood of tree crown ignition and torching behavior (Scott and Reinhardt 2001).

The shrub and small tree fuel stratum also influences crown fire ignition and spread potential to a significant degree because it tends to buttress surface fire intensity and serves as "ladder fuel" that facilitates vertical movement of fires from the ground surface into the overstory canopy. The size (height) of the spatial gap between the ground surface and tree crowns is a key determinant of crown ignition potential (Graham et al. 2004). Van Wagner (1977) demonstrates that crown fires ignite after surface fires reach critical fireline intensity relative to the height of the base of aerial fuels in the tree crown. In turn, crown ignition can become a running (i.e., passive or active) canopy fire if its spread rate surpasses a canopy fuel density threshold that varies with site-specific slope angle and wind speed. Reducing the risk of active canopy fire that spreads among tree crowns independent of surface fire behavior may require heavy thinning to separate tree crowns by decameters, depending on stand structure and degree of acceptable risk. Where canopy bulk density reduction is proposed, predictions about the relationship between stand structure and active crown fire risk will depend on the validity of canopy bulk density calculations and estimates (Perry et al. 2004).

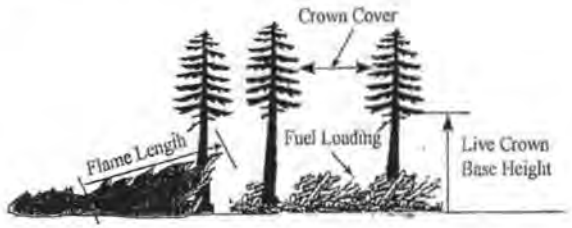

Figure IV-7. Forest stand structural elements that influence stand replacing wildland fire effects. Surface fuel loading and vertical height to live tree crowns exert the greatest influence on canopy fire initiation. Source: Agee (1996).

Omi and Martinson (2002) sampled several forest areas in the western United States, including ponderosa pine forest, where active vegetation management preceded wildfire to describe the effectiveness of fuel treatments on subsequent fire effects. They reported a strong correlation between crown base height and "stand damage," which they described as a measure of fire severity. Importantly, crown bulk density did not strongly correlate with observed fire severity. According

to the study,

> height to live crown, the variable that determines crown fire initiation rather than propagation, had the strongest correlation to fire severity in the areas we sampled... [W]e also found the more common stand descriptors of stand density and basal area to be important factors. But especially crucial are variables that determine tree resistance to fire damage, such as diameter and height. Thus, "fuel treatments" that reduce basal area or density from above (i.e., removal of the largest stems) will be ineffective within the context of wildfire management.

A key implication of the research quoted above is that treating forest stands "from below" by reducing surface and ladder fuels is critical to prevent widespread occurrence of stand replacing fires. Keyes and O'Hara (2002) agree that stand-scale crown base height is the central consideration in fire hazard mitigation, and argue, "pruning lower dead and live branches yields the most direct and effective impact." Keyes and O'Hara (2002) also note the incompatibility of open forest conditions created by heavy thinning of canopy fuels with management objectives including conservation of canopy-dependent wildlife populations and prevention of rapid fire propagation in understory fuels as well as ladder fuel development over time.

Perry and others (2004) investigated the relationship of forest structure with susceptibility to severe fire effects in ponderosa pine forests in Oregon. Their results show, even in areas uniformly far departed from the historical fire regime, "there may be a great deal of landscape heterogeneity in the degree of risk and the treatments required to lower risk" (Perry et al. 2004: 923). Fire treatments that reduced surface fuel load by fifty percent (50%) without any tree thinning prevented torching behavior in 13 of 14 experimental plots, even with wind speeds exceeding 90th percentile conditions. And a "light" thinning prescription that thinned only trees smaller than 12" dbh coupled with surface fuel reduction by prescribed fire prevented torching in the remaining plot (Perry et al. 2004). Those results agree with observations of the 2002 Hayman fire in Colorado, where extreme crown fires dropped to the ground upon encountering areas that had been treated with prescribed fire to reduce surface fuels and kill small trees (Graham 2003).

At larger spatial scales, the direction of fire spread (backing, flanking, heading) is an important determinant of fire behavior and its biological effects because fire interacts with weather, topography and vegetation to "back" and "flank" around certain fuel and topographic conditions, or "head" through others as it moves across the landscape (Graham et al. 2004). Steep slopes can facilitate wind-driven convection currents that drive radiant heat upward and bring flames nearer to adjacent unburned vegetation, pre-heating fuels and amplifying fire intensity as it moves upslope. As a result, severe fire effects typically concentrate at upper slope positions and on ridges, whereas such effects are relatively rare on the lee side of slopes that do not directly receive frontal wind (Whelan 1995). Forest Service research showed that the size and severity of an unplanned ignition may be greatly reduced if fuel treatments are placed in a staggered, overlapping pattern that is perpendicular to the prevailing wind and treatment prescriptions are sufficient to reduce expected rate of spread and flame length (Finney 2001).

17-3 Fuel treatments should be designed with spatial patterns of fire spread in mind. The agency's science and experience show that fuel management can be unnecessary and counterproductive if it is not spatially arranged to take advantage of site-specific topography and weather patterns (Finney 2001). Moreover, Peterson and Johnson (2007) posed questions regarding the efficacy of different fuel treatment options at various spatial scales that should be addressed in the project analysis. To the degree that the project also may increase the effectiveness of fire suppression, the analysis must consider effects on the environment resulting from connected and cumulative fire suppression activities (Backer et al. 2004).

17-4

Dwarf mistletoe

Some forest stands in the project area undoubtedly host dwarf mistletoe (*Arceuthobium vaginatum*). The pathogen creates important features of wildlife habitat, including food resources of a number of sensitive and at-risk species, and it promotes mortality in large trees, which contributes to old growth forest structure and spatial heterogeneity at stand scales (Nicholls et al. 1984). Dwarf mistletoe is inherent to the natural disturbance ecology of healthy uneven-aged forests (Conklin and Fairweather 2010). Indeed, clump- and group-scale mistletoe infections create uneven-aged structure at larger spatial scales (Nicholls et al. 1984).

Trees infected with dwarf mistletoe can directly or indirectly benefit wildlife (Filip 2005). Many vertebrate animal species consume mistletoe shoots and fruits, and use brooms for cover and as nesting sites (Hawksworth and Wiens 1996, Mathiasen 1996). Mistletoe shoots are an important fall and winter food source for porcupine (*Erethizon dorsatum*) (Hooven 1971, Lawrence 1957). Chipmunks (*Tumius* spp.) commonly eat mistletoe seeds (Broadbooks 1958, Nicholls et al. 1984). Squirrels (*Sqiurus* spp.) and porcupines feed selectively on mistletoe-infected twigs (Johnson and Carey 1979, Wood et al. 1985) and use brooms as winter resting cover (Smith 1982). Mistletoe has high nutritive value (Umess 1969), and when their shoots fall to the ground, they are accessible to deer. Mistletoe shoots are a regular high-protein component in the diet of mule deer (*Odocoileus hemionus*) (Leach and Hiele 1957, Wright and Arrington 1950). Clary and Larson (1971) found that in certain years, ponderosa pine stands with dwarf mistletoe shelter significantly more deer than stands without dwarf mistletoe.

Tassel-eared squirrel (*Sqiurus aberti*) (Dodd et al. 1998, Dodd and Rosenstock 2003, Dodd 2003, Mathiasen et al. 2004), northern goshawk (*Accipiter gentilis*) (Hayward and Escano 1989, Reynolds et al. 1992) and Mexican spotted owl (*Strix occidentalis lucida*) (USDI 1995, Grubb et al. 1997) prefer heterogeneous habitat patches that include large trees, relatively dense canopy, and diverse structure including coarse wood and mistletoe brooms. Those animals are threatened by large scale fires and by habitat degradation associated with silvicultural management (Beier and Machinski 2003).

17-5

Northern goshawk

The latest report of the Kaibab National Forest on management indicator species habitat and population trends (USDA 2010) states that the source population of northern goshawk on the Kaibab Plateau is in decline, and the species is "at risk of extirpation or extinction in Arizona." The Forest Service must ensure that the project will not adversely affect goshawk or contribute to a trend toward listing under the Endangered Species Act.

17-6

The amended Kaibab Forest Plan incorporates the *Management Recommendations for the Northern Goshawk in the Southwestern United States* (Reynolds et al. 1992), which quantifies structural attributes of habitat for northern goshawk and 14 of the hawk's prey species. To date, two environmental impact statements on forest planning in the Southwestern Region have based action alternatives and decisions on those recommendations (USDA 1996, 2006). In doing so, the Forest Service established a habitat-proxy relationship of ponderosa forest structure and viability of northern goshawk, and applied a proxy-on-proxy assumption to its analysis of population viability for 14 vertebrate prey species.

The Arizona Game and Fish Department repeatedly has expressed concern to the Forest Service that application of canopy cover guidelines derived from the *Management Recommendations* (Reynolds et al. 1992) at small clump- and group-scales (generally <1 acre) instead of at larger forest stand scales has the potential to significantly reduce the amount of forest cover within areas subject to vegetation treatment, with detrimental consequences to goshawk and its prey. For example, assuming a residual canopy cover of 50 percent within tree groups (< 1 acre) after vegetation treatment, and if such groups occupy 50 percent of a stand (>2 acres), canopy cover at the stand scale will be 25 percent. To prevent this outcome in site-specific projects, which clearly would harm goshawk and its prey, the *Management Recommendations* (Reynolds et al. 1992) and the amended forest plans incorporating them, including the Kaibab Forest Plan, require maintenance of canopy cover at stand scales in goshawk nesting and fledging habitat.

17-7 The Kaibab National Forest developed a white paper entitled *Implementation and Interpretation of Management Recommendations for the Northern Goshawk, Version 3.0* ("I&I" – USDA 2009) that calls for assessment of forest treatment effects to goshawk habitat at small clump- and group-scales, and not at the larger scale of a forest stand. This interpretation of guidelines for goshawk habitat in the amended forest plan shifts requirements for maintenance of canopy cover and vegetative structural stages from the stand scale to smaller scales. Its use in the current project requires an amendment to the forest plan.

Independent of the scale of application, continued implementation the *Management Recommendations* (Reynolds et al. 1992) is scientifically controversial as a means of insuring population viability for goshawk and prey species. The Coconino Forest Biologist wrote to her colleagues that a study of influences of ponderosa pine forest structure on northern goshawk reproduction conducted by Beier and others (2008) "sort of rocks the world for the 1996 goshawk guidelines."[2] Beier and others (2008) detected a negative correlation of goshawk breeding productivity with territories that were treated by logging consistent with the *Management Recommendations* (Reynolds et al. 1992) and the amended forest plans. That finding agrees with observations of Silver and others (unpublished), who found evidence of the same phenomenon in the Kaibab National Forest, and stated, "Goshawks are known to be adapted to hunt in, and to prefer closed forests… [L]ogging continues to negatively impact goshawk reproduction, regardless of the guidelines."[3]

17-8 Finally, the Center encourages the Forest Service to avoid creating forest openings larger than two (2) acres in the project. At a 2005 meeting with Forest Service biologists, Dr. Reynolds stated: "Do not create openings 4 acres in size unless there is an overriding management need, keep openings small."[4] Please refer to comments above for reasons why mistletoe treatments may not justify openings larger than forest plan guidelines allow.

Mexican spotted owl

17-9 The project area overlaps habitat of threatened Mexican spotted owl. Logging, road construction and prescribed firing activities may affect spotted owl critical habitat. Smoke accumulation from prescribed burning may flush owls from nests, causing incidental take. Therefore, the Forest Service is required to complete formal consultation with the U.S. Fish and Wildlife Service ("FWS") culminating in a biological opinion and incidental take statement to secure exemption of the proposed action from the Endangered Species Act's ("ESA") prohibition of take of listed species.

On June 10, 2005, the FWS completed a programmatic biological opinion for the "continued implementation of the Land and Resource Management Plans for the Eleven National Forest and National Grasslands of the Southwestern Region," including the Kaibab National Forest. The FWS and the Forest Service agreed that implementing the forest plans would adversely affect 36 listed species and would incidentally take several of them, including threatened Mexican spotted owl. The FWS determined that the anticipated level of owl take was most appropriately quantified in terms of the number or percent of Protected Activity Centers ("PAC") with disturbance and/or habitat alteration. FWS anticipated that take is reasonably certain to occur within 5 percent of the total PACs in the form of harm and 5 percent of the total number of PACs in the form of harassment for a total of a 10 percent as a result of the proposed action. The anticipated take is set forth per recovery unit. The FWS and the Forest Service agreed to annually review and evaluate the actual incidental take for project-specific actions.

To be exempt from the Section 9 ESA prohibition on take as it implements forest plans in the Southwestern Region, including the Kaibab Forest Plan, the Forest Service must comply with the terms and conditions of the June 10, 2005 incidental take statement. The terms and conditions for the Mexican spotted owl include specific monitoring requirements. The Forest Service must monitor Mexican spotted owl PAC occupancy pursuant to the most recent version of the owl recovery plan. This monitoring must assess changes in owl site occupancy rates so that management actions can be adjusted if changes in owl populations occur. Additionally, in order to monitor the impacts of incidental take, the Forest Service must track and report the effects of the forest plans on Mexican spotted owls.

In October, 2008, the Forest Service provided its "Annual Report" for period June 10, 2005 through June 10, 2007, regarding the programmatic biological opinion on the land and resource management plans for the 11 national forests in the Southwest Region. The Forest Service acknowledged in the report that it is not complying with the monitoring requirements set forth in the biological opinion's terms and conditions, and/or has likely exceeded the allowable incidental take, for a number of listed species, including the Mexican spotted owl.

The Forest Service typically monitored only 20-25% of PACs during 2005-07. Moreover, PACs have been monitored for owl occupancy but not owl reproduction. The Forest Service states in the annual report that personnel and funding levels are not adequate to meet the monitoring requirements set out in Term and Condition 3.1. As a result, in many cases, monitoring has not been accomplished. In addition, the Forest Service claims in the report that the incidental take issued by the biological opinion is difficult to understand at the Forest level.

On April 17, 2009, the Forest Service wrote a letter to FWS to request the re-initiation of formal consultation on the 2005 biological opinion. According to the April 17th letter, "[i]t has now become apparent that the Forest Service will likely soon exceed the amount of take issued for at least one species, the Mexican spotted owl." Additionally, "it has become apparent that the Forest Service is unable to fully implement and comply with the monitoring requirements associated with the Reasonable and Prudent Measures for several species (including MSO) in the [biological opinion]." FWS has accepted the Forest Service's April 17th request and reinitiated formal consultation on the forest plans in this region, including the Kaibab Forest Plan.

17-10 Despite its admission of ongoing monitoring deficiencies, potential exceedance of incidental take, and non-compliance with the mandatory terms and conditions of the 2005 biological opinion, the Forest Service continues to approve site-specific projects that may affect Mexican spotted owl. The Forest Service is violating the mandatory terms and conditions set forth in the 2005 biological opinion concerning the implementation of the Forest Plans in the Southwest Region, including mandatory monitoring requirements for the Mexican spotted owl, in violation of the ESA. 16 U.S.C. § 1536(b)(4)(C)(iv); 50 C.F.R. §§ 402.14(i)(1)(iv), and 402.14(i)(3). Due to these monitoring failures, the Forest Service is also failing to insure that it has not exceeded the incidental take allowances for these species. Therefore, the agency should withhold approval of actions that may affect Mexican spotted owl pending reconsultation to insure that the proposed action will not irretrievably commit owls or their habitat.

Cumulative effects

17-11 The project area has experienced potentially significant cumulative impacts from past management. Consideration and disclosure of cumulative impacts must include the following issues within the project area:

- All past shelter-wood seed cuts and clear cuts, including their impacts on overall canopy cover, old growth quality and extent, and habitat suitability for canopy dependent species such as and including tassel-eared squirrel and northern goshawk.

- All past crown fires, including their impacts on overall canopy cover, old growth quality, quantity and extent, and habitat suitability for canopy dependent species including squirrel and goshawk.

- Past changes in forest structure, including those resulting from fires, and their impacts on wildlife habitat and populations.

- Invasive plant populations occurring in past timber sales, along roads and in past fire perimeters, and the potential for the proposed action and/or spatially or temporally concurrent management to introduce and increase invasive plant populations within the project area. This analysis should also evaluate invasive plant population responses to climate, seasonality, soil, slope, aspect, land uses, management activities, timing and interactions therein.

- Overall fire management goals for the project area, including and especially wildland fire use.

- Location of the project area and proposed management activities, including roads and skid trails, in relationship to the location of important wildlife habitat, both formally protected habitats and other important habitat, such as wildlife movement corridors.

17-12 Moreover, livestock grazing is an important factor influencing forest health and fire regimes. There is a substantial body of scientific literature that identifies livestock grazing as a major factor in the alteration of historic fire regimes and contributor to fire hazard (Arnold 1950, Cooper 1960, Madany and West 1983, Mitchell and Freeman 1993, Rummell 1951, Savage and Swetnam 1994). If active grazing allotments overlap the planning area then we would be very concerned about potentially significant cumulative effects to soil, plant communities, fire regimes and wildlife forage that may result from active range management in combination with proposed treatments. Livestock grazing, logging, prescribed fire, off-road vehicle use, and other practices that disturb soils can spread noxious weeds. Livestock act as vectors for seed travel, disturb soil, and reduce the competitive and reproductive capacities of native species. Exotic weeds can displace native species, in part, because native grasses are not adapted to frequent and close grazing (Mack and Thompson 1982, Belsky and Blumenthal 1997).

The project area overlaps at least one grazing allotment. In addition to altering forest structure and composition, livestock grazing contributes to the long-term and degradation of grasslands utilized by indicator species such as pronghorn antelope. The sustainability of grassland habitats throughout the Kaibab National Forest is threatened by encroachment of noxious and invasive weeds as well as woody vegetation. Seager and others (2007) surveyed models of regional climate found broad consensus supporting projection of "Dust Bowl" aridity as "the new climatology of the American Southwest within a time frame of years to decades." Bradley (2009) determined that decreased precipitation, particularly in the summer, causes an expansion of suitable land area for cheat grass invasion. Cheat grass invasion can significantly change grassland fire regimes with synergistic and self-reinforcing effects to community composition resulting in type conversion (Brooks et al. 2004, Westerling et al. 2006).

17-13 Noxious weed spread is a reasonably foreseeable and potentially significant forest-wide cumulative impact of the proposed action. Treatments similar to the proposed action have left forest restoration sites overrun with cheatgrass (*Bromus tectorum*) (McGlone et al. 2009). Although it is not extensive in the planning area today, cheatgrass invasion has important long-term implications for native plant communities in fire-adapted ecosystems and wildlife associated with grassland habitats, including management indicator species like pronghorn antelope. Melgoza and others (1990) studied cheat grass soil resource acquisition after fire and noted its competitive success owing to its ability suppress the water uptake and productivity of native species for extended periods of time. They further showed that cheat grass dominance is enhanced by its high tolerance to grazing. Its annual life-form coupled with the abilities to germinate readily over a wide range of moisture and temperature conditions, to quickly establish an extensive root system, and to grow early in the spring contribute to its successful colonization. In addition, Melgoza and others (1990) showed that cheat grass successfully competes with the native species that survive fire, despite these plants being well-established adult individuals able to reach deeper levels in the soil. This competitive ability of cheat grass contributes to its dominance when lands experience synergistic disturbances from grazing and fire.

Please contact me with any questions regarding this letter, and keep me apprised of all developments in analysis and decision making regarding the Bill Williams Project.

Sincerely,

Jay Lininger, Ecologist

P.O. Box 25686
Albuquerque, NM 87125
Tel: (928) 853-9929
Email: jlininger@biologicaldiversity.org

Att.

REFERENCES

Abella, S.R., P.Z. Fulé and W.W. Covington. 2006. Diameter caps for thinning southwestern ponderosa pine forests: viewpoints, effects, and tradeoffs. *Journal of Forestry* (Dec): 407-414.

Agee, J.K. 1996. The influence of forest structure on fire behavior. Pp. 52-68 in: J.W. Sherlock (chair). *Proc. 17th Forest Vegetation Management Conference.* 1996 Jan. 16-18: Redding, CA. Calif. Dept. Forestry and Fire Protection. Sacramento, CA.

Agee, J.K., and C.N. Skinner. 2005. Basic principles of forest fuel reduction treatments. *Forest Ecology and Management* 211:83-96.

Allen, C.D. M.A. Savage, D.A. Falk, K.F. Suckling, T.W. Swetnam, T. Schulke, P.B. Stacey, P. Morgan, M. Hoffman, and J.T. Klingle. 2002. Ecological restoration of southwestern ponderosa pine ecosystems: A broad perspective. *Ecological Applications* 12:1418-1433.

Amaranthus, M.P., D.S. Parrish, and D.A. Perry. 1989. Decaying logs as moisture reservoirs after drought and wildfire. Pp. 191-194 in: E.B. Alexander (Ed.). *Proceedings of Watershed '89: Conference on the Stewardship of Soil, Air, and Water Resources*. USDA For. Serv. Alaska Region. RIO-MB-77. Anchorage, AK.

Arno, S.F. 2000. Fire in western ecosystems. Pp. 97-120 in: J.K. Brown and J.K. Smith (Eds.). *Wildland Fire in Ecosystems, Vol. 2: Effects of Fire on Flora*. USDA For. Serv. Gen. Tech. Rep. RMRS-42-vol.2. Ogden, UT.

Arnold, J.F. 1950. Changes in ponderosa pine bunchgrass ranges in northern Arizona resulting from pine regeneration and grazing. *Journal of Forestry* 48: 118-126.

Backer, D.M, S.A. Jensen, and G.R. McPherson. 2004. Impacts of fire suppression activities on natural communities. *Conservation Biology* 18:937-946.

Beier, P., and J. Maschinski. 2003. Threatened, endangered, and sensitive species. Pp. 206-327 in: P. Friederici (Ed.). *Ecological Restoration of Southwestern Ponderosa Pine Forests*. Island Press: Washington, D.C.

Beier, P., E.C. Rogan, M.F. Ingraldi and S.S. Rosenstock. 2008. Does forest structure affect reproduction of northern goshawks in ponderosa pine forests? *Journal of Applied Ecology* 45: 342-350.

Belsky A.J. and D.M. Blumenthal. 1997. Effects of livestock grazing on stand dynamics and soils in upland forests of the Interior West. *Conservation Biology* 11:316-327.

Billings, W.D. 1990. *Bromus tectorum*, a biotic cause of ecosystem impoverishment in the Great Basin. Pp. 301-322. In: G.M. Woodwell (Ed.). *The Earth in Transition*. Cambridge University Press: New York.

Bradley, B.A. 2009. Regional analysis of the impacts of climate change on cheatgrass invasion shows potential risk and opportunity. *Global Change Biology* 14:196-208.

Brooks, M.L., C.M. D'Antonio, D.M. Richardson, J.B. Grace, J.E. Keeley, J.M. DiTomaso, R.J. Hobbs, M. Pellant and D. Pyke. 2004. Effects of invasive alien plants on fire regimes. *BioScience* 54:677-688.

Broadbooks, H.E. 1958. *Life history and ecology of the chipmunk,* Eutamias amoenus, *in eastern Washington*. Univ. Michigan Museum of Zoology Misc. Publ. 103. Ann Arbor, MI. 42 p.

Brown, R.T., J.K. Agee, and J.F. Franklin. 2004. Forest restoration and fire: principles in the context of place. Conservation Biology 18:903-912.

Clary, W,P., and F.R. Larson. 1971. *Elk and Deer Use Are Related to Food Sources in Arizona Ponderosa Pine.* USDA For. Serv. Rocky Mtn. Res. Sta. Res. Note RM-RN-202. Fort Collins, CO. 4 p.

Conklin, D.A. and M.L. Fairweather. 2010. *Dwarf Mistletoes and Their Management in the Southwest*. USDA For. Serv. R3-FH-10-01. Albuquerque, NM. 23 pp.

Cooper, C.F. 1960. Changes in vegetation, structure and growth of southwestern pine forests since white settlement. *Ecological Monographs* 30:129-164.

Countryman, C.M. 1956. Old-growth conversion also converts fire climate. *Fire Control Notes* 17(4):15-19.

Covington, W.W., P.Z. Fule, M.M. Moore, S.C. Hart, T.E. Kolb, J.N. Mast, S.S. Sackett, and M.R. Wagner. 1997. Restoring ecosystem health in ponderosa pine forests of the southwest. *Journal of Forestry* 95(4):23-29.

Covington, W.W., and M.M. Moore. 1994. Southwestern ponderosa forest structure: Changes since Euro-American settlement. *Journal of Forestry* 92:39-47.

DellaSala, D.A., J.E. Williams, C.D. Williams and J.F. Franklin. 2004. Beyond smoke and mirrors: a synthesis of fire policy and science. *Conservation Biology* 18:976-986.

Dodd, N.L. 2003. *Landscape-scale habitat relationships to tassel-eared squirrel population dynamics in Arizona: index techniques and relationships to habitat condition*. Arizona Game and Fish Department Technical Guidance Bulletin 6: Phoenix, AZ.

Dodd, N.L., J.S. States, and S.S. Rosenstock. 2003. Tassel-eared squirrel population, habitat conditions, and dietary relationships in north-central Arizona. *Journal of Wildlife Management* 67:622-633.

Dodd, N.L., S.S. Rosenstock, C.R. Miller, and R.E. Schweinsburg. 1998. *Tassel-eared squirrel population dynamics in Arizona: index techniques and relationships to habitat condition*. Arizona Game and Fish Department Technical Report 27: Phoenix, AZ.

Falk, D.A. 2006. Process-centered restoration in a fire-adapted ponderosa pine forest. *Journal for Nature Conservation* 14:140-151.

Fiedler, C.E., and C.E. Keegan. 2002. Reducing crown fire hazard in fire-adapted forests of New Mexico. Pp. 29-38 in: P.N. Omi and L.A. Joyce (Tech. Eds.). *Fire, Fuel Treatments, and Ecological Restoration: Conference Proceedings*. 2002 April 16-18: Fort Collins, CO. USDA For. Serv. Rocky Mtn. Res. Sta. Proc. RMRS-P-29. Fort Collins, CO.

Finney, M.A. 2001. Design of regular landscape fuel treatment pattern for modifying fire growth and behavior. *Forest Science* 47:219-228.

Friederici, P. (Ed.). 2003. *Ecological Restoration of Southwestern Ponderosa Pine Forests*. Island Press: Washington, DC.

Filip, G.M. 2005. Diseases as agents of disturbance in ponderosa pine. Pp. 227-232 in: M.W. Ritchie, D.A. Maguire, and A. Youngblood (Tech. Coord.). *Proc. Symp. on Ponderosa Pine: Issues, Trends, and Management*. 2004 Oct. 18-21: Klamath Falls, OR. USDA For. Serv. Pac. So. Res. Sta. Gen. Tech. Rep. PSW-GTR-198. Albany, CA.

Fulé, P.Z., W.W. Covington, and M.M. Moore. 1997. Determining reference conditions for ecosystem management of Southwestern ponderosa pine forests. *Ecological Applications* 7:895-908.

Graham, R.T. (Ed.). 2003. *Hayman Fire Case Study*. USDA For. Serv. Rocky Mtn. Res. Sta. Gen. Tech. Rep. RMRS-GTR-114. Ogden, UT.

Graham, R.T., S. McCaffrey, and T.B. Jain (Tech. Eds.). 2004. *Science Basis for Changing Forest Structure to Modify Wildfire Behavior and Severity*. USDA For. Serv. Rocky Mtn. Res. Sta. Gen. Tech. Rep. RMRS-120. Ft. Collins, CO.

Graham, R.T., A.E. Harvey, T.B. Jain, and J.R. Tonn. 1999. *The Effects of Thinning and Similar Stand Treatments on Fire Behavior in Western Forests.* USDA For. Serv. Pac. Nor. Res. Sta. Gen. Tech. Rep. PNW-GTR-463. Portland, OR.

Grubb, T.L., J.L. Ganey, and S.R. Masek. 1997. Canopy closure around nest sites of Mexican spotted owls in north-central Arizona. *Journal of Wildlife Management* 61:336-342.

Hampton, H.M., S.E. Sesnie, B.G. Dickson, J.M. Rundall, T.D Sisk, G.B. Snider and J.D. Bailey. 2008. *Analysis of Small-Diameter Wood Supply in Northern Arizona*. Forest Ecosystem Restoration Analysis Project, Center for Environmental Sciences and Education, Northern Arizona University: Flagstaff. 210 pp.

Hawksworth, F.G., and D. Wiens. 1996. *Dwarf Mistletoes: Biology, Pathology, and Systematics*. USDA Agric. Handb. 709. Washington, DC. 410 p.

Hayward, G.D. and R.E. Escano. 1989. Goshawk nest-site characteristics in western Montana and northern Idaho. *Condor* 91:476-479.

Hooven, E.F. 1971. *The Porcupine in Oregon: Its Life History and Control*. Oregon State Univ. For. Res. Lab. Res. Publ. 10. Corvallis, OR. 22 p.

Hunter, M.E., W.D. Shepperd, J.E. Lentile, J.E. Lundquist, M.G. Andreu, J.L. Butler, and F.W. Smith. 2007. *A Comprehensive Guide to Fuels Treatment Practices for Ponderosa Pine in the Black Hills, Colorado Front Range, and Southwest*. USDA For. Serv. Rocky Mtn. Res.

Sta. Gen. Tech. Rep. RMRS-GTR-198. Fort Collins, CO.

Kaufmann, M.R., W.H. Moir, and W.W. Covington. 1992. Old-growth forests: what do we know about their ecology and management in the Southwest and Rocky Mountain regions? Pp. 1-10 in: M.R. Kaufmann, W.H. Moir, and R.L. Bassett (Eds.). *Old-Growth Forests in the Southwest and Rocky Mountain Regions: Proceedings from a Workshop* (1992). Portal, AZ. USDA For. Serv. Gen. Tech. Rep. RM-213. Fort Collins, CO.

Johnson, M.C., D.L. Peterson and C.L. Raymond. 2007. *Guide to Fuel Treatments in Dry Forests of the Western United States: Assessing Forest Structure and Fire Hazard*. USDA For. Serv. Pac. Nor. Res. Sta. Gen. Tech. Rep. PNW-GTR-686. Portland, OR.

Johnson, M.K., and A.B. Carey. 1979. Porcupine pellet pH, color, and composition. *Southwestern Naturalist* 24:544-545.

Keeley, J.E. and P.H. Zedler. 1998. Evolution of life histories in *Pinus*. Pp. 219-250 in: D.M. Richardson (ed.). *Ecology and Biogeography of* Pinus. Press Syndicate of the Univ. Cambridge: Cambridge, U.K.

Keyes, C.R. and K.L. O'Hara. 2002. Quantifying stand targets for silvicultural prevention of crown fires. *Western Journal of Applied Forestry* 17:101-109.

Lawrence, W.H. 1957. Porcupine control: a problem analysis. *Forestry Research Notes*. Weyerhaeuser Timber Company: Centralia, WA. 43 p.

Leach, H.R., and J.L. Hiele. 1957. Food habits of the Tehama deer herd. *California Fish and Game* 43:161-178.

Mack, R. N., and J. N. Thompson. 1982. Evolution in steppe with few large, hooved mammals. American Naturalist 119:757-772.

Madany, M.H. and N.E. West. 1983. Livestock-grazing-fire regime interactions within montane forest of Zion National Park, Utah. *Ecology* 64:661-667.

McCune, B. 1988. Ecological diversity in North American pines. *American Journal of Botany* 75: 353-368.

McGlone, C.M., J.D. Springer and W.W. Covington. 2009. Cheatgrass encroachment on a ponderosa pine forest ecological restoration project in northern Arizona. *Ecological Restoration* 27:37-46.

McHugh, C.W. and T.E. Kolb. 2003. Ponderosa pine mortality following fire in northern Arizona. *International Journal of Wildland Fire* 12:7-22.

Melgoza, G., R.S. Nowak and R.J. Tausch. 1990. Soil water exploitation after fire: competition between *Bromus tectorum* (cheatgrass) and two native species. *Oecologica* 83:7-13.

Mitchell, J.E. and D.R. Freeman. 1993. Wildlife-livestock-fire interactions on the North Kaibab: a historical review. USDA For. Serv. Rocky Mtn. Res. Sta. Gen. Tech. Rep. GTR-RM-222. Fort Collins, CO.

Martinson, E.J., and P.N. Omi. 2003. Performance of fuel treatments subject to wildfires. In: P.N. Omi and L.A. Joyce (Tech. Eds.). *Fire, Fuel Treatments, and Ecological Restoration: Conference Proceedings*. 2002 April 16-18: Fort Collins, CO. USDA For. Serv. Rocky Mtn. Res. Sta. Proc. RMRS-P-29. Fort Collins, CO.

Mathiasen, R.L. 1996. Dwarf mistletoes in forest canopies. *Northwest Science* 70:61-71.

Mathiasen, R.L., G.N. Garnett, and C.L. Chambers, C.L. 2004. A comparison of wildlife use in broomed and unbroomed ponderosa pine trees in northern Arizona. *Western Journal of Applied Forestry* 19:42-46.

Naficy, C., A. Sala, E.G. Keeling, J. Graham and T.H. DeLuca. 2010. Interactive effects of historical logging and fire exclusion on ponderosa pine forest structure in the northern Rockies. *Ecological Applications* 20:1851-1864.

Nicholls, T.H., F.G. Hawksworth, and L.M. Merrill. 1984. Animal vectors of dwarf mistletoe, with special reference to *Arceuthobium americanum* on lodgepole pine. Pp. 102-110 in: F.G. Hawksworth and R.F. Scharpf (Eds.). *Biology of Dwarf Mistletoes: Proceedings of a Symposium*; 1984 August 8; Fort Collins, CO. USDA For. Serv. Rocky Mtn. Res. Sta. Gen. Tech. Rep. RM-GTR-111. Fort Collins, CO.

Noss, R., P. Beier, W. W. Covington, R. E. Grumbine, D. B. Lindenmayer, J. W. Prather, F. Schmiegelow, T. D. Sisk, and D. J. Vosick. 2006. Recommendations for integrating restoration ecology and conservation biology in ponderosa pine forests of the Southwestern United States. *Restoration Ecology* 14:4-10.

Nowicki, B., and R. George. 2004. *A Scientific Critique of the Myths and Misconceptions of Logging Old Growth and Large Diameter Ponderosa Pine in the Southwest*. Southwest Forest Alliance. 9pp.

Omi, P.N., and E.J. Martinson. 2002. *Effect of Fuels Treatment on Wildfire Severity*. Unpubl. report to Joint Fire Science Prog. Western Forest Fire Research Ctr., Colorado St. Univ. Fort Collins, CO. March 25. 36 pp.

Perry, D.A., H. Jing, A. Youngblood, and D.R. Oetter. 2004. Forest structure and fire susceptibility in volcanic landscapes of the eastern high Cascades, Oregon. *Conservation Biology* 18:913-926.

Peterson, D.L. and M.C. Johnson. 2007. Science-based strategic planning for hazardous fuel treatment. *Fire Management Today* 67(3):13-18.

Pollett, J. and P.N. Omi. 2002. Effect of thinning and prescribed burning on crown fire severity in ponderosa pine forests. *International Journal of Wildland Fire* 11:1-10.

Randall-Parker, T., and R. Miller. 2002. Effects of prescribed fire in ponderosa pine on key wildlife habitat components: preliminary results and a method for monitoring. Pp. 823-834 in: W.F. Laudenslayer, et al. (Tech. Coords.). *Proc. Symp. Ecology and Management of Dead Wood in Western Forests*. 1999 November 2-4; Reno, NV. USDA For. Serv. Pac. So. Res. Sta. Gen. Tech. Rep. PSW-GTR-181. Albany, CA.

Reynolds, R.T., R.T. Graham, M.H. Reiser, R.L. Bassett, P.L. Kennedy, D.A. Boyce, G. Goodwin, R. Smith, and E.L. Fisher. 1992. *Management Recommendations for the Northern Goshawk in the Southwestern United States*. USDA For. Serv. Rocky Mtn. Res. Sta. Gen. Tech. Rep. RM-GTR-217. Fort Collins, CO.

Rummell, R.S. 1951. Some effects of livestock grazing on ponderosa pine forest and range in central Washington. *Ecology* 32:594-607.

Running, S.W. 2006. Is global warming causing more, larger wildfires? *Science* 313:927.

Sackett, S.S., S.M. Hasse, and M.G. Harrington. 1996. Lessons learned from fire use for restoring Southwestern ponderosa pine ecosystems. In: W.W. Covington, and M.R. Wagner (Eds.). *Conference on Adaptive Ecosystem Restoration and Management: Restoration of*

Cordilleran Conifer Landscapes of Northern America. USDA For. Serv. Rocky Mtn. Res. Sta. Gen. Tech. Rep. RM-GTR-278. Fort Collins, CO.

Sandberg, D.V., R.D. Ottmar, and G.H. Cushon. 2001. Characterizing fuels in the 21st century. *International Journal of Wildland Fire* 10:381-387.

Savage, M. and T.W. Swetnam. 1990. Early 19th century fire decline following sheep pasturing in a Navajo ponderosa pine forest. *Ecology* 71:2374-2378.

Savage, M. P.M. Brown, and J. Feddema. 1996. The role of climate in a pine forest regeneration pulse in the southwestern United States. *Ecoscience* 3:310-318.

Scott, J.H. 1998. *Fuels Reduction in Residential and Scenic Forests: A Comparison of Three Treatments in a Western Montana Ponderosa Pine Stand*. USDA For. Serv. Rocky Mtn. Res. Sta. Res. Paper RMRS-RP-5. Fort Collins, CO.

Scott, J.H., and E.D. Reinhardt. 2001. *Assessing Crown Fire Potential by Linking Models of Surface and Crown Fire Behavior*. USDA For. Serv. Rocky Mtn. Res. Sta. Res. Pap. RMRS-RP-29. Fort Collins, CO.

Seager, R., M. Ting, Y. Kushnir, J. Lu, G. Vecchi, H. Huang, N. Harnik, A. Leetmaa, N. Lau, C. Li, J. Velez and N. Naik. 2007. Model projections of an imminent transition to a more arid climate in southwestern North America. *Science* 316:1181-1184.

Sesnie, S. and J. Bailey. 2003. Using history to plan the future of old-growth ponderosa pine. *Journal of Forestry* (Oct/Nov): 40-47.

Smith, G.W. 1982. Habitat use by porcupines in a ponderosa pine/Douglas-fir forest in northeastern Oregon. *Northwest Science* 56:236-240.

Urness, P.J. 1969. Nutritional analysis and in vitro digestibility of mistletoes browsed by deer in Arizona. *Journal of Wildlife Management* 33:499-505.

USDA Forest Service. 2010. *Management Indicator Species of the Kaibab National Forest: An Evaluation of Population and Habitat Trends, Version 3.0*. Kaibab National Forest: Williams, AZ.

_____. 2009. *Implementation and Interpretation of Management Recommendations for the Northern Goshawk, Version 3.0*. Kaibab National Forest: Williams, AZ. August. 23 pp.

_____. 2007. Forest Inventory and Analysis National Program—Forest Inventory Data Online (FIDO). http://www.fia.fs.fed.us/tools-data/

_____. 2006. *Final Supplemental Environmental Impact Statement for Amendments to Forest Plans*. Southwestern Region: Albuquerque, NM.

_____. 1999. Forest Inventory and Analysis National Program—Forest Inventory Data Online (FIDO). http://www.fia.fs.fed.us/tools-data/

_____. 1996. *Final Environmental Impact Statement for Amendments to Forest Plans*. Southwestern Region: Albuquerque, NM.

USDI Fish and Wildlife Service. 1995. *Mexican Spotted Owl Recovery Plan*. Region 2: Albuquerque, NM.

Van Wagner, C.E. 1977. Conditions for the start and spread of crown fire. *Canadian Journal of Forest Research* 7:23-24.

Wallin, K.F., T.E. Kolb, K.R. Skov, and M.R. Wagner. 2003. Effects of crown scorch on ponderosa pine resistance to bark beetles in northern Arizona. *Environmental Entomology* 32:652-661.

Watson, D.M. 2001. Mistletoe – a keystone resources in forests and woodlands worldwide. *Annual Review of Ecological Systematics* 32: 219-249.

Weaver, H. 1951. Fire as an ecological factor in the southwestern ponderosa pine forests. *Journal of Forestry* 49(2): 93-98.

Westerling, A.L., H.G. Hidalgo, D.R. Cayan and T.W. Swetnam. 2006. Warming and earlier spring increase western U.S. forest wildfire activity. *Science* 313: 940-943.

Whelan, R.J. 1995. *The Ecology of Fire*. Cambridge Univ. Press: New York.

Williams, A.P., C.D. Allen, C.I. Millar, T.W. Swetnam, J. Michaelsen, C.J. Still and S.W. Leavitt. 2010. Forest responses to increasing aridity and warmth in the southwestern United States. *PNAS* 107: 21289-21294.

Wood, C.S., G.A. Van Sickle, and T.L. Shore. 1985. Forest insect and disease conditions, British Columbia. Canada Forestry Service, Pacific Forest Research Centre Info. Rep. BC-X-259. Victoria, BC. 32 p.

Wright, J.T., and O.N. Arrington. 1950. *The Cooperative Kaibab North Livestock-Deer Forage Relationship Study*. Arizona Game and Fish Dept. Federal Aid Completion Report Project W-27-R-1, 2 and 3. Phoenix, AZ. 223 p.

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[1]

See notes of Arizona Game and Fish Deptartment Region II Commission Briefing, July 27, 2007, attached to these comments for convenience. In it, the Department explains, "the Management Recommendations for the Northern Goshawk in the Southwestern United States (GTR-RM-217) defines northern goshawk habitat through the structural habitat attributes of 14 of the hawk's prey species. The canopy cover data described for these prey species, and for the northern goshawk, were measured at the stand level – not the tree group level. By changing the canopy cover targets from the stand level to the group level, the Department is concerned that the Forest Service may not be meeting the habitat requirements for those 14 wildlife species, and also may not be meeting the habitat requirements for the northern goshawk per the 1996 Forest Plan Amendment."

[2]

See electronic mail of Cecelia Overby re: "Beier et al. paper," Feb. 26, 2008 ("The authors conclude that the Forest Service should reconsider its decision to apply the guidelines to most of the forested lands in the region. Wow.").

[3]

CBD analysis of data secured via FOIA citing the "analysis 2005 work 010506."

[4]

See notes of Forest Service meeting with Richard Reynolds, northern goshawk expert, Dec. 7 & 8, 2005, at Williams Ranger District, Kaibab National Forest.

Image001.emz

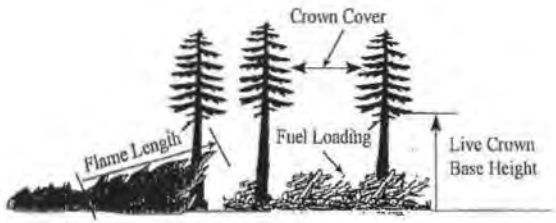

Figure IV-7. Forest stand structural elements that influence stand replacing wildland fire effects. Surface fuel loading and vertical height to live tree crowns exert the greatest influence on canopy fire initiation. Source: Agee (1996).

Image003.emz

Table 1. Tree size class distribution in southwestern ponderosa pine forests.

Size class	Distribution
< 11 inches dbh	82%
< 15 inches dbh	96%
> 16 inches dbh	3%
> 21 inches dbh	0.1%

Source: Forest Inventory and Analysis National Program
Forest Inventory Data Online (FIDO). http://www.fia.fs.fed.us/tools-data/

Image005.emz

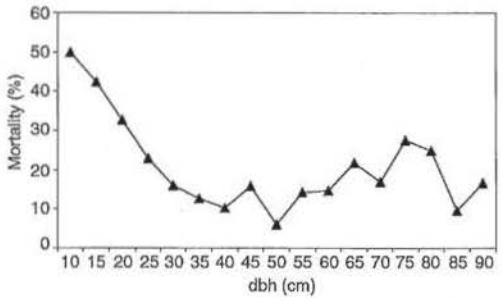

Fig. 3. Observed percent mortality of ponderosa pine 3 years after fire by 5 cm dbh class for data combined over three fires in northern Arizona. Data are not shown for dbh classes with <3 trees.

Image007.emz

Region II Commission Briefing July 27, 2007

U.S. Forest Service

TMR
The Coconino National Forest has scheduled a third round of public meetings on the Travel Management Rule July 31 to August 4. In this round of public meetings the Forest will be presenting a proposed action including maps and will be taking Public Comment. The Department will be represented at all four meetings. The Kaibab has not scheduled any more public meetings or made any decisions at this point.

Forest Plan Revision
The Kaibab has said they hope to resume collaborative efforts on the Plan Revisions in September. The following are excerpts from the letter we received:

> *"Nationally, the Forest Service has filed a notice to prepare an environmental impact statement to address the flaws identified by the court in the 2005 Rule process. The Arizona Forests have all continued to work on several tasks associated with Plan revision in a manner consistent with the National Forest Management Act and neutral with respect to the various planning rules that might apply. The Kaibab NF will continue to work on those over the next several months to identify needs for change to the Plan. We intend to do much of this with those of you who would like to help us.*
>
> *The work many of you helped us with previous to the court ruling is not lost. Nearly all of it will continue to be used in identifying the needs for change. Specifically:*
>
> - *Public participatory processes will resume. Although the 2005 Rule was the only one that required collaboration, none of the others prohibited it, and we think it's a good idea.*
> - *We will continue to aim for a more strategic, less prescriptive Plan as an end product, with a primary focus upon desired conditions and objectives to make progress toward the desired conditions.*
> - *Sustainability analyses are continuing in order to ensure compliance with the requirements of NFMA. We are preparing a rough draft of the ecological sustainability report, incorporating information and public input for the two primary parts of this analysis – ecosystem diversity and species diversity. While we are not sure how species will eventually be addressed in the Plan, the information developed with your help is captured in a database that will serve as an invaluable reference, regardless of which process we use. We have finished a rough draft of our social and economic sustainability report, incorporating information and public input. Once these sustainability analyses have been reviewed internally, we will share them and engage in dialogue with our publics to identify the social and economic needs for change.*
>
> *Beginning in late September, we hope to resume public processes to continue this work, aiming toward completion of a comprehensive assessment of the needs to change the Plan this winter. As we move through the summer, we will be sending you specifics about meeting topics, times and places"*

Plan revision efforts have been extremely quite and the Region has not been involved on any of the Forests.

Goshawk Guidelines
The Department has concern about a shift in how the Forest Service implements their own Northern Goshawk Guidelines within the current Forest Plan. One of the primary concerns the Department has with the new interpretation is that forest thinning treatments have the potential to reduce overall tree canopy cover to levels that may not meet the habitat needs for wildlife within those treated areas. The Department has vetted these concerns at several meetings and has been unable to resolve these concerns with the Forest Service. All previous Forest Service planning projects have planned canopy cover reduction levels at the stand level. Under the new interpretation of the goshawk guidelines, the Forest Service is proposing target canopy cover ranges at the group level as opposed to the stand level (where a group is defined as an aggregation of one or more clumps of trees of varying age and size interspersed with openings).

The Management Recommendations for the Northern Goshawk in the Southwestern United States (GTR-RM-217) defines northern goshawk habitat through the structural habitat attributes of 14 of the hawk's prey species. The canopy cover data described for these prey species, and for the northern goshawk, were measured at the stand level – not the tree group level. By changing the canopy cover targets from the stand level to the group level, the Department is concerned that the Forest Service may not be meeting the habitat requirements for those 14 wildlife species, and also may not be meeting the habitat requirements for the northern goshawk per the 1996 Forest Plan Amendment.

Related to the new Forest Service guidance for implementing the northern goshawk guidelines, the Department is also concerned that Forest Service proposed treatment might trend toward even-aged group selection over time. For example, the Forest Service proposed to regenerate groups of VSS1 and 2 while reducing canopy cover for tree groups of other VSS classes. Managing tree groups by VSS class comes across as even-aged tree group management. However, scientific literature describing the historic range of variability in southwestern ponderosa pine does not find that tree groups were even aged. Rather, the literature suggests that tree groups were often comprised of multi-aged trees intermingled intimately in the same area (Long and Smith 2000, Mast et al. 1999, White 1985). Uneven aged tree composition within groups is important for vertical structure and provides forage and breeding habitat for songbirds as well as thermal cover for raptors as well as deer and elk.

Department personnel from Regions I and II, Research Branch, Nongame Branch and Habitat Branch attended a workshop on the new interpretation in Flagstaff including a field trip to stands marked under the new interpretation. All the Department personnel who attended the workshop were concerned that the degree of openness permitted under the new interpretation because of its potential to negatively impact forest wildlife including goshawk squirrel, bear, turkey, and dense forest songbirds.

The Forests have decided that they do not need to do any NEPA on these changes because they believe it is simply clarification of existing guidance. The Department is of the opinion that the Forests should have gone through the NEPA process, or at minimum consulted with the state and federal fish and wildlife agencies. Consultation, or a forum for discussion, is necessary between the Forests and the Department to resolve these concerns.

Regional Wood Supply Analysis

The Department is participating in the Wood Supply Working Group, which just recently held its second (of 7) meetings. The WSWG is comprised of natural resource agencies and wood utilization private industries; the group is facilitated through a Forest ERA (NAU – Tom Sisk's Lab) grant; and the grant is funded by the Forest Service. The group is tasked with estimating the amount of small-diameter ponderosa pine wood that would be available from forest restoration projects, for the purpose of establishing a small-diameter wood industry. As per the Governor's Forest Health Strategy, and other regional economic assessments, landscape-scale restoration of fire-adapted ecosystems is unaffordable under current contracting processes. The only way to see landscape scale treatments be implemented would be to allow small diameter wood industries to pay for the restoration treatments. Wood industries, however, are only willing to pay for these treatments if they know the wood supply will be adequate to cover the costs and generate profit.

The Department supports this effort, as long as the analysis is driven by goals of forest restoration, wildlife habitat, and restoration of fire-adapted ecosystems (as opposed to designing treatments that maximize industry gain and encourage long-term extraction of trees beyond the goals of forest restoration). The analysis uses a GIS approach, and the Department has worked successfully to ensure that threatened and endangered species habitat, riparian habitat, and wildlife movement corridors are considered during the analysis. A product from this WSWG is expected in fall 2007.

Kaibab National Forest

Westside Habitat Improvement/Slide Fire:

On July 5, 2007 at 2:30 pm lightning ignited a fire within the Westside project area. This fire burned about 6,000 acres and burned sections of the treatment area defined as pinyon/juniper push areas, pinyon juniper woodlands, upland areas, and valley bottoms. The fire burned in a mosaic pattern and a majority of the fire was low to moderate intensity. A significant portion of the fire burned over the acreage burned in the 1996 Bridger fire. A Burned Area Emergency Response (BAER) team was formed and several rehabilitation treatments for the areas that burned at a moderate to high intensity are planned for implementation. As stated in the draft BAER report, the goal for the treatments is for the control of cheatgrass not for erosion control.

During the time of the fire, it was recognized by the media radio and press releases that this area is in quality mule deer habitat. Region II had the opportunity to comment on the initial report and suggested to the team that they incorporate shrub seed into the treatments to aid in the return of winter browse species; and that they consider increasing the amount of early successional native grasses as opposed to planting sterile rye. There is evidence in the literature that if successfully germinated, sterile rye grasses can impede the establishment of native vegetation.

At the present time, the fire has not slowed plans for implementation on the Westside. There may be slight modifications in timing of seeding and herbicide treatments however; the Department still plans on seeding 500 acres of desirable browse species in the fall of 2007. The Region has been working with Truax Drills, Inc. who has been developing an interseeding tool that will seed shrubs into existing vegetation. Jim will be coming out to do a site visit on the 30th of July to the Westside treatment area to hone in on specifications for the tool as well as look at current conditions within the fire footprint and beyond.

Currently, pinyon and juniper habitat treatments are expected to resume on the Westside next week. Forest closures due to dry conditions as well as the wildfire halted implementation for several weeks. The contractor continues to do an excellent job removing juniper from historic push treatments. This type of treatment will continue throughout the summer.

Coconino National Forest

Senate Bill 1441 Progress on Anderson Mesa Grassland Restoration

Both the grassland restoration and the lake fencing are on going since the last commission briefing. Approximately an additional 1500 acres of grassland restoration and 200 acres of seeding have been completed. This brings us up to approximately 2600 total acres of grassland restoration and 530 acres of seeding. Diablo trust is currently talking with additional contractors and considering hiring more crews to speed up the work.

GFFP

The Department continues to participate in the Greater Flagstaff Forests Partnership (GFFP) on two primary projects: 1. Completion of the Jack Smith/Schultz Fuels Reduction Project NEPA planning, and 2. Ensuring that the Forest's and GFFP's commitment to assisting with Research Branch's wildlife research in the wildland-urban interface of GFFP projects is honored. While the scope and future activities of GFFP are still uncertain at this time, the Department will continue to follow GFFP activities and gauge the benefit of our continued participation.

BLM Arizona Strip District:

Upper Lang's Run Integrated Vegetation Management:

The Department commented on a draft EA for a 9,000-acre watershed vegetation project near Mount Trumbull. The Strip District is beginning to look at planning at a watershed level, which will increase acreages associated with treatments. While the Department is in full support of this type of planning, it has become increasingly important to be involved with all stages of the project. We have been working well with the District on this project; however, we have some concerns that not all the appropriate tools are being addressed as possibilities to meet vegetation objectives. For example, many of the conditions in the project area are that of an overstory of pinyon and juniper with little to no understory. At this point the BLM plans to thin some of the overstory, but has not fully explored methods to do so, as well as how to incorporate appropriate seeding techniques. The Department has plans for several field trips to this project area and is confident at this point that our issues will be heard and at lease partially incorporated into project planning.

OTHER

Colorado Plateau Native Plant Initiative (CPNPI) and the Northern Arizona Native Seed Association (NANSA)

During the week of June 11th, Regional staff attended the Colorado Plateau Native Plant Initiative Meeting in Moab, Utah.

For several years, state, federal, and non-profit groups in Utah have been engaged with the development of native plant materials on the northern part of the Colorado Plateau. Region II has worked with members of these groups over the last 2 years in gaining skills in how to use these native plant materials on the landscape, specifically related to the Westside Project on the North Kaibab Ranger District. With increasing habitat degradation due to fire, drought, and excessive grazing, important AZ wildlife habitat continues to be at risk. To date, the limiting factor for habitat restoration is adequate native plant materials.

Until recently, the scale of Utah's native plant program did not include the southern part of the Colorado Plateau or any of AZ to speak of. This status is changing and the main reason for this meeting was to work toward joining the existing groups into one Colorado Plateau Native Plant Initiative, and the expansion of efforts Colorado Plateau wide. At this time, AZ groups and agencies are welcomed, invited, and encouraged to participate. The group is not asking for money at this time but more importantly ideas and needs for the program. Because this group is just starting, there is an opportunity to be in an active, leadership role from the states perspective. The UTDWR has had a successful habitat restoration program for years, and should the Dept. head in this direction, the Region recommends that we utilize their experience.

Notes from the 1st Colorado Plateau Native Plant Initiative are available upon request. Opportunities to learn and participate more in the program will become available in September at a Restoration Workshop in Grand Junction, CO and in early November at The Ninth Biennial Conference of Research on the Colorado Plateau, Flagstaff, AZ.

At a more local level, the Northern Arizona Native Plant Association (NANSA) had an additional meeting in July. This group continues to work as a sub-group of the CPNPI. This group hopes to raise awareness within the local area for the need for native seed, work on developing a market for local seed, and continue to work on small native seeding projects. Although this group has only recently formed, there is now the potential for a coordinator, which will expedite the ability to gather interest and apply for grant money.

Coconino County

We are actively engaged in the Coconino County Parks and Recreation effort to sell a conservation easement on Pumphouse Greenway to NRCS through the Farm Bill's Wetland Reserve Program. The Department is currently working with Coconino County and NRCS to develop a conservation plan for the easement that will restore and enhance the wetlands of Pumphouse Greenway, reduce wildlife disturbances and control human/domestic dog access within the wetland, and provide substantially more Watchable Wildlife developments for the area. Planning is almost complete, and the easement purchase is scheduled to occur in November 2007. The Department recently participated in a public meeting on the Pumphouse WRP, where we presented information on wildlife habitat in the wetlands as well as Watchable Wildlife opportunities.

Naval Observatory INRMP

We attended a meeting and reviewed a draft plan for the management of natural resources on the Naval Observatory.

THE STATE OF ARIZONA
GAME AND FISH DEPARTMENT
2221 WEST GREENWAY ROAD
PHOENIX, AZ 85023-4399
(602) 942-3000 • AZGFD.GOV
REGION II, 3500 S. LAKE MARY ROAD, FLAGSTAFF, AZ 86001

GOVERNOR
JANET NAPOLITANO
COMMISSIONERS
CHAIRMAN, MICHAEL M. GOLIGHTLY, FLAGSTAFF
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ROBERT R. WOODHOUSE, ROLL
DIRECTOR
DUANE L. SHROUFE
DEPUTY DIRECTOR
STEVE K. FERRELL

Gene Waldrip
District Ranger, Peaks Ranger District
5075 N. Highway 89
Flagstaff, AZ 86004

RE: Comments on the Jack Smith/Schultz Fuel Reduction and Forest Health Project Proposed Action

5 June 2007

Dear Mr. Waldrip,

The Arizona Game and Fish Department (Department) has reviewed the Jack Smith/Schultz Project: Proposed Action (PA) by the Coconino National Forest Peaks Rangers District (FS). The Department appreciates the extensive opportunities for collaborative participation with the FS Inter-disciplinary Team (IDT) and the Greater Flagstaff Forest Partnership (GFFP) during development of the Proposed Action.

The Department would like to take this opportunity to acknowledge the progress the FS has made over the last several GFFP-collaborative fuels reduction project in their approach toward forest restoration and wildlife habitat. We have seen a positive evolution in FS-GFFP proposed actions that will result in more heterogeneous forest stand structure that provides higher quality wildlife habitat for multiple species. In particular, the Department would like to thank the IDT for their willingness to craft language within the PA that explicitly defines the terms they used to describe spatial heterogeneity (e.g., tree groups and stand openings). Clumpy/groupy stand structure tends to offer better vertical diversity, thermal and hiding cover, as well as better foraging opportunity for wildlife than does a more evenly-aged, evenly-spaced forested stand. The stand structure described in the PA will provide wildlife habitat that more closely resembles the historic range of variability than would a homogeneous stand structure, and the Department acknowledges the IDT's efforts to achieve these conditions within the PA.

Moreover, the Department appreciates the IDT's efforts to ensure that there is a diversity of group sizes within the stands of the project area, and that the amount of forested area in canopy cover is well-represented within the range of canopy covers proposed. For example, in the Schultz Pass WUI West Zone, the FS proposed a minimum of 25% of groups will retain canopy cover greater than 50%, 50% of groups will be retained with canopy cover between 40 and 50%, and no more than 25% of groups will reain canopy cover between 30 and 40%. This type of planning helps to ensure that some groups will be large in size with higher canopy cover, which is an important forest characteristic upon which many wildlife species depend, particularly passerines, turkeys, raptors, mule deer, and black bear.

However, the Department reserves some concern about the proposed shift in how the FS plans to reduce overall tree canopy cover within treated areas. The Department has vetted these concerns during several IDT and GFFP meetings and has been unable to resolve these concerns with the FS. All previous FS-GFFP planning projects have planned canopy cover reduction levels at the stand level. In this PA, the FS is proposing target

canopy cover ranges at the group level as opposed to the stand level (where a group is defined as an aggregation of one or more clumps of trees of varying age and size interspersed with openings). The Department finds that this change has the potential to significantly reduce the amount of forest cover within treated areas. For example, the PA proposes to reduce the forested area in certain zones to between 30-50%. Canopy cover within that forested area will be reduced to 30-60%. Under this proposal, overall canopy cover in this management zone could be reduced to as little as 10% canopy cover if measured across the stand. Without considering the average canopy cover across stands, the Department has some concerns that the FS may not meet the canopy cover requirements for wildlife in the project area.

It is our understanding that the decision to reduce canopy cover at the group level is based on Region 3 guidance, per a new interpretation of the northern goshawk guidelines within the 1996 Forest Plan Amendment (#11). However, the Department has received no formal documentation of the new interpretation.

The Management Recommendations for the Northern Goshawk in the Southwestern United States (GTR-RM-217) defines northern goshawk habitat through the structural habitat attributes of 14 of the hawk's prey species. The canopy cover data described for these prey species, and for the northern goshawk, were measured at the stand level – not the tree group level. By changing the canopy cover targets from the stand level to the group level, the Department is concerned that the FS may not be meeting the habitat requirements for those 14 wildlife species, and also may not be meeting the habitat requirements for the northern goshawk per the 1996 Forest Plan Amendment.

Related to the new FS guidance for implementing the northern goshawk guidelines, the Department is also concerned that FS proposed treatment may trend toward even-aged group selection over time. For example, the FS proposed to regenerate groups of VSS1 and 2 while reducing canopy cover for tree groups of other VSS classes. Managing tree groups by VSS class comes across as even-aged tree group management. However, scientific literature describing the historic range of variability in southwestern ponderosa pine does not find that tree groups were even aged. Rather, the literature suggests that tree groups were often comprised of multi-aged trees intermingled intimately in the same area (Long and Smith 2000, Mast et al. 1999, White 1985). Uneven aged tree composition within groups is important for vertical structure and provides forage and breeding habitat for songbirds as well as thermal cover for raptors as well as deer and elk.

The Department requests the FS consider our concerns regarding overall canopy cover across stands as well as across the treated areas, and recommend the FS carefully evaluate potential impacts this canopy cover reduction might have on wildlife habitat during the Effects Analysis. The Department also requests any formal documentation that may be available describing the new Region 3 guidance for interpreting the northern goshawk guidelines, as well as an opportunity to formally comment on that new interpretation.

Thank you for the opportunity to comment on the Jack Smith/Schultz PA. We acknowledge the IDT efforts to carefully describe resultant forest structure post-treatment, and we look forward to continued cooperation on implementation of this important forest restoration and community protection project. If you have any questions or require additional information, please contact Sarah Lantz, Urban Wildlife Planner at 928-607-0650, slantz@azgfd.gov.

Sincerely,

Sarah Lantz

Cecelia Overby/R3/USDAFS
02/26/2008 11:02 AM

To pdl r3 forest biologists@FSNOTES, Barbara G Phillips/R3/USDAFS@FSNOTES, Bobbi L Barrera/R3/USDAFS@FSNOTES, Ronnie
cc
bcc
Subject Fw: Beier et al. paper

FYI, a paper that sort of rocks the world for the 1996 goshawk guidelines. The strongest pattern in their results was that "...production of fledglings decreased as the breeding area's similarity to the goshawk guidelines increased." The authors conclude that the Forest Service should reconsider its decision to apply the guidelines to most of the forested lands in the region. Wow.

Cecelia

Cecelia Overby
Forest Biologist, Wildlife and Fisheries
Coconino National Forest
1824 S. Thompson St.
Flagstaff, Arizona 86001
(928) 527-3460

---- Forwarded by Cecelia Overby/R3/USDAFS on 02/26/2008 10:42 AM ----

"Susan MacVean" <SMacVean@azgfd.gov>
02/25/2008 10:45 AM

To <coverby@fs.fed.us>, <bnoble@fs.fed.us>, <jwaters@fs.fed.us>, <hprovencio@fs.fed.us>, <joertley@fs.fed.us>, "Janie Agyagos" <jagyagos@fs.fed.us>, <shaula_hedwall@fws.gov>, <clthompson@fs.fed.us>, <bagarcia@fs.fed.us>, "Roger E Joos" <rejoos@fs.fed.us>
cc
Subject FW: Beier et al. paper

In case you hadn't already seen this...

Susi

beier et al 2008 goshawks.pdf

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Does forest structure affect reproduction of northern goshawks in ponderosa pine forests?

Paul Beier[1]*, Erik C. Rogan[1], Michael F. Ingraldi[2] and Steven S. Rosenstock[2]

[1]*School of Forestry and Merriam-Powell Center for Environmental Research, Northern Arizona University, Flagstaff AZ 86011, USA; and* [2]*Arizona Game and Fish Department, 2221 West Greenway Road, Phoenix, AZ 85023, USA*

Summary

1. Many management prescriptions are based on ecological hypotheses; evaluating empirical support for these hypotheses can improve management. There has been considerable dispute about the potential response of the northern goshawk to three management-driven forest structures in ponderosa pine forests of the south-western United States: (i) the structure recommended by US Forest Service's goshawk guidelines, designed to increase the abundance of 14 goshawk prey species and thus benefit goshawks; (ii) preferred foraging habitat as suggested by empirical evidence that goshawks forage selectively in areas with abundant large trees and dense canopy closure, rather than areas of highest prey abundance; and (iii) presettlement (i.e. prior to Euro-American settlement) structure characterized by clumps of large trees, canopy closure < 40% and dense herbaceous understorey, which could have negative effects on goshawks.

2. To evaluate empirical support for hypotheses that goshawk reproduction is affected by each of these three forest structures, we measured forest structure in a 1215-ha nest-centred circular area in each of 13 goshawk breeding areas on the Apache–Sitgreaves National Forest, Arizona. The breeding areas were selected to span the full range of productivity (fledglings per year monitored) over the previous 9-year period.

3. Forest structure had a moderate effect on goshawk productivity ($r^2 \leq 0{\cdot}46$). Contrary to expectation, goshawk productivity decreased with increasing similarity to the goshawk guidelines.

4. Goshawk reproduction was not correlated with resemblance of the breeding area to preferred foraging habitat or resemblance to presettlement forest conditions.

5. *Synthesis and applications.* Because the goshawk guidelines may not improve goshawk reproduction, the Forest Service should reconsider its decision to apply the guidelines to most forested lands in Arizona and New Mexico. Managers should evaluate empirical support routinely for the major ecological hypotheses that underlie forest prescriptions.

Key-words: *Accipiter gentilis*, ecological restoration, forest management, forest structure, *Pinus ponderosa*, reproductive success, vegetative structural stage

Introduction

The northern goshawk *Accipiter gentilis* L. is a species of concern in Arizona (Arizona Game and Fish Department, undated) and a US Forest Service sensitive species in Region 3 (US Forest Service 1993a). The goshawk population in the western United States was evaluated for listing under the Endangered Species Act in 1992 and 1998 (US Fish & Wildlife Service 1998). Concern over the status of the goshawk prompted the US Forest Service to develop management recommendations for National Forests in Arizona and New Mexico (Reynolds *et al.* 1992; referred to hereafter as 'goshawk guidelines'). In 1996, the goshawk guidelines were incorporated into amendments of all Forest Plans in these two states (US Forest Service 1995, 1996). The amendments require the goshawk guidelines to be implemented on all Forest Service forestlands that are not managed for Mexican spotted owls (*Strix occidentalis lucida*). A fundamental assumption of the goshawk guidelines is that the 'goshawk is a forest habitat generalist that uses a variety of forest types, forest ages, structural conditions, and successional stages' (Reynolds *et al.* 1992: 1). Reasoning that 'if goshawk populations are a barometer of their prey populations, then forest management should feature prey habitats', Reynolds *et al.* (1992) prescribed a forest structure that should provide abundant populations of 14 prey species. Following Reynolds *et al.* (1992), we use the term forest structure to include descriptors such as tree density, diameter distribution, canopy closure, numbers of snags and logs and basal area.

*Correspondence author. E-mail: paul.beier@nau.edu

Greenwald *et al.* (2005) provide an alternative concept of ideal goshawk habitat. Their review of habitat use studies in North America (11 of 12 published after the goshawk guidelines) suggests that goshawk foraging locations within their home ranges are characterized by many large [> 40·6 cm diameter at breast height (d.b.h.)] trees and dense (> 40%) canopy closure, but that goshawks do 'not select stands with the greatest prey abundance' (Greenwald *et al.* 2005: 120). Although none of the studies reviewed by Greenwald *et al.* (2005) hypothesized that goshawk reproduction or survival would be highest in goshawk breeding areas with many large trees and dense canopy closure, this is a reasonable hypothesis from these observations.

In these same south-western forests, ecological restoration of ponderosa pine (*Pinus ponderosa*) and pine-oak (*Quercus* species) forests has been proposed to reverse changes to forest structure and function caused by a century of livestock grazing, fire suppression and timber harvest, and to reduce the risk of stand-replacing wildfires (Covington & Moore 1994). Accordingly, managers in the region are proposing treatments to restore conditions that prevailed prior to Euro-American settlement. Compared to current forest structure, these presettlement conditions are characterized by lower basal area, stem density and canopy closure, and a larger fraction of the landscape dominated by large trees (Fulé, Covington & Moore 1997; Mast *et al.* 1999; Fulé *et al.* 2002; Waltz *et al.* 2003). Concern that presettlement forest structure will affect goshawk populations adversely is one of the main issues raised by environmental advocacy groups opposed to implementation of restoration treatments (US Fish and Wildlife Service 1998).

Managers would benefit from an empirical assessment of how these three alternative forest structures would affect goshawks. Although direct experiments would be ideal, managers would have to assign randomly a statistically useful number of goshawk territories to required treatments and controls, and it would take decades to implement treatments and monitor goshawk response. We chose a less direct but more expedient approach by correlating goshawk reproduction with similarity of goshawk breeding areas to each of these three alternative forest structures.

Several previous studies have related stand characteristics to goshawk reproduction (Crocker-Bedford 1990, 1995; Ward, Ward & Tibbets 1992; Patla 1997; Finn, Marzluff & Farland 2002). Although each of these studies provided useful information about how reproduction varies with one or more forest trait, no study addressed these particular forest structures directly or compared empirical support for alternative hypotheses. Furthermore, these studies were limited to relatively short monitoring periods: 3–7 years per territory (Patla 1997) or 1–3 years per territory (all other studies). Monitoring reproduction for > 3 years is appropriate because goshawk reproduction in western North American landscapes fluctuates widely among years, probably driven by changes in weather and prey abundance (Kennedy 1997; Krüger & Lindström 2001; McClaren, Kennedy & Dewey 2002). One possibility is that forest structure affects reproduction only during years of high fledging success, other years being so poor that the influence of habitat is obscured. For example, Bloxton (2002) observed that goshawk reproduction virtually ceased in La Niña years (years of low precipitation in western North America driven by cold ocean temperatures in the equatorial Pacific), overriding habitat effects. Alternatively, forest structure might influence reproduction only in years of poor reproduction; for example, Krüger & Lindström (2001) observed that in good years all goshawk territories had high productivity with little variation among breeding areas.

To address these issues, we related goshawk nest productivity over a 9-year period to forest structure in landscapes around 13 goshawk breeding areas in ponderosa pine and pine–oak forests on the Apache–Sitgreaves National Forest in Arizona. Our objective was to assess how reproductive success of goshawks varied with similarity of goshawk breeding areas to three alternative forest structures (goshawk guidelines, preferred foraging habitat, presettlement conditions) over a time span that included a range of climatic conditions typical of the South-western United States.

Methods

STUDY AREA

We studied goshawks on the Black Mesa and Lakeside Ranger Districts of the Apache–Sitgreaves National Forest in east-central Arizona. The study area is part of the Mogollon Plateau, an area dominated by basaltic and limestone type soils that forms the uplifted southern edge of the Colorado Plateau and is dominated by ponderosa pine. Elevations in the study area ranged from 1768 to 2417 m (mean 2134 m). In these breeding areas, silverleaf oak (*Q. arizonica*), pinyon pine (*P. edulis*), alligator juniper (*Juniperus deppeana*) and Utah juniper (*J. osteosperma*) frequently co-occurred with ponderosa pine, especially at lower elevations or on south-facing slopes. At higher elevations and in steep canyons, co-dominant species were Douglas fir (*Pseudotsuga menziesii*), white fir (*Abies concolor*), and aspen (*Populus tremuloides*). Gambel oak (*Q. gambelii*) and New Mexico locust (*Robinia neomexicana*) were common understorey tree species throughout. Annual precipitation at the nearest weather station (Show Low Airport, 2102 m elevation) averaged 39·9 cm during 1993–2002, with driest years in 2002 (24·5 cm) and 1996 (31·4 cm), and relatively wet years in 1993 (53·4 cm), 1994 (50·7 cm) and 1997 (46·6 cm).

Our research activities occurred within a 1215-ha circle (radius 1967 m) from the geographical centroid of each area's known nest locations. To avoid the implication that these circles correspond exactly to goshawk territories, we use the term 'goshawk breeding areas' to refer to these circular areas.

None of the goshawk breeding areas in our study experienced timber harvest in > 8% of the breeding area (mean 2·8%, range 0–7·6%) during 1993–2002. Thus we believe that the goshawk reproduction we observed was not affected by disturbance or other short-term effects of timber harvest.

MONITORING GOSHAWK REPRODUCTION

During 1991–2002, the Arizona Game and Fish Department, US Forest Service (USFS) and Northern Arizona University collaborated to monitor northern goshawks in the study area. Each year, we first visited each historic northern goshawk breeding area in April and May to determine occupancy and locate any active nest. An historic breeding area was a nest site or cluster of nests where an incubating goshawk was observed at least once during the previous 3 years. If occupancy was not confirmed at historic nest sites, we conducted visual searches within a 1·6 km radius around the centroid of known nests, excluding pinyon–juniper woodlands, meadows or other treeless areas. Following USFS South-western Region's northern goshawk inventory protocols (Kennedy & Stahlecker 1993; Joy, Reynolds & Leslie 1994), we also broadcast conspecific recordings to elicit responses from northern goshawks. Playback tapes provided by the USFS included both the adult 'alarm' call and the female 'wail' call. The alarm call was used from June to early July (nestling period) and the wail call was used from late July to early September (fledgling period). Because Woodbridge & Detrich (1994) found 95% of alternative nests within 800 m of the last known nest, we placed 24 calling points uniformly throughout an 800-m radius area around previous nest sites. If we could not verify nesting activity in an occupied area early in the season, we conducted a second survey during the fledgling dependency period (August). We spent up to 7 person-days searching a breeding area before considering it unoccupied.

An area was considered occupied if a pair of goshawks were inferred to use the area during at least part of the breeding season, based on presence of a new or refurbished nest, an adult bird at or near a nest on ≥ 2 occasions, or fresh mutes, moulted feathers and prey remains around a nest structure (Ingraldi 1999). A nest was considered active if we observed a female goshawk in incubation posture, at least one fresh egg or egg shell fragments or fledgling or juvenile northern goshawks (Ingraldi 1999). Active nests were visited at least once every 10 days to monitor status and productivity.

A nest was deemed successful if at least one nestling survived to 100% of fledgling age (39 days old; Steenhof 1987). Ages were determined using Hoyt's (1994) photographic guide, or by the observed number of days since hatching. Productivity was measured as number of nestlings that survived at least 39 days, unless there was subsequent evidence that the nestlings did not fledge.

We used fledglings per year monitored (occupancy rate times productivity per occupied nest) as a measure of reproductive success. Nest productivity is a problematic measure because it considers only nest areas where pairs are present and initiate breeding but ignores intermittent use or early abandonment of lower quality sites (McClaren *et al.* 2002). Krüger & Lindström (2001) found that breeding pairs of goshawks occupied progressively poorer breeding sites as number of breeding pairs increased, i.e. only the best sites were occupied in years with few nesting attempts. Fledglings per year monitored incorporates both measures. Similarly, Wiens & Reynolds (2005: 210) found that the number of fledglings produced per adult goshawk over a 10-year period was 'a reliable index of fitness' (which they defined as recruitment to the breeding population). We did not use data for the first year each breeding area was discovered because by definition an area with a newly discovered nest could not be classified as unoccupied.

From all 46 goshawk breeding areas known and monitored annually for all or part of 1993–2002, we excluded 18 breeding areas because > 50% of the breeding area was dominated by either pinyon–juniper or mixed conifer vegetation types and four breeding areas at which major disturbance (campground construction, timber harvest in > 10% of the area during the 10-year period) occurred during the monitoring period. Because most goshawks in this region nest in forests dominated by ponderosa pine, we confined our attention to breeding areas in that forest type. We then selected the five most productive and five least productive breeding areas, and selected three areas randomly with intermediate productivity. For these 13 areas, we calculated fledglings produced per breeding area (see Table S1 in Supplementary material).

MEASURING FOREST STRUCTURE

After the 10 years of monitoring, when all nest locations had been determined, we measured forest structure in each of the 13 breeding areas. We mapped one sample point per 4·05 ha (10 acres) throughout each breeding area (~300 points per breeding area), assigned each point a Universal Transverse Mercator (UTM) location, and used global positioning system (GPS) units to locate each point on the ground.

Based on radio-telemetry studies, Reynolds *et al.* (1992) posited three key components to a goshawk home range: nest areas (73 ha divided among three alternate nest areas and three replacement areas); a post-fledging family area (170 ha near the nest used by the female and fledglings from incubation through juvenile dispersal); and a foraging area (2185 ha of additional foraging area for the male goshawk). Areas close to the nest may have a different influence on goshawk reproduction than do more distant areas. Thus we evaluated forest structure in two areas: a circular area centred on the geographical centroid of the breeding area's nest locations, and a larger annulus around this circle. The 243-ha circle (radius 880 m, ~60 sample points) was intended to encompass the nest areas and post-fledging family area; for brevity we refer to this circle as the Central Zone of a goshawk breeding area. The annulus was the area within a circle of radius 1967 m, excluding the Central Zone, and thus encompassed 972 ha (~240 sample points) of the foraging area closest to the nest; we refer to this area as the Foraging Band. Totalling 1215 ha, these areas represent half of a 2430-ha home range for a pair of breeding goshawks (Reynolds *et al.* 1992; Kennedy *et al.* 1994). Funding limitations precluded sampling additional breeding areas, or the entire foraging area.

We collected forest stand data at each point, using USFS intensive (Level I) stand examination procedures (US Forest Service 1993b). At each sample point we placed three concentric plots: (1) variable-radius plot utilizing a 10 basal area factor (BAF) prism within which we recorded d.b.h., height and species for each live tree; (2) 0·405-ha (1-acre) circular plot within which we tallied all snags > 25·4 cm d.b.h. and logs > 25·4 cm at midpoint; and (3) a 0·00405-ha (0·01-acre) fixed circular plot within which we tallied all seedlings and saplings < 12·7 cm d.b.h. Our minimum size thresholds for tallying snags and logs correspond to snag and log definitions in Reynolds *et al.* (1992).

After calculating basal area by species, we used USFS algorithms to calculate three derived variables at each point: forest type, canopy closure class and dominant diameter class. We recognized 10 forest types [non-forest, ponderosa pine, oak, pinyon–juniper (PJ), aspen, mixed conifer, pine–oak, pine–PJ, oak–PJ and PJ–oak] based on the basal area of each tree species with respect to thresholds defined by Eyre (1981) and US Fish and Wildlife Service (1995: 52–58). We estimated canopy closure class from percentage of a theoretical maximum Stand Density Index (SDI) for each forest type using the USFS algorithm (McTague & Patton 1989; US Forest Service 1993b) and maximum SDI values for each forest type proposed by Long (1985). Canopy closure class boundaries were 40% canopy closure (corresponding to 30% maximum SDI), 50% canopy closure (corresponding to 39% of maximum SDI) and 60% (corresponding to 47% maximum SDI). We recognized six diameter classes, designated 1–6, corresponding to the Vegetative Structural Stages (VSS) used in USFS Region 3 (Reynolds *et al.* 1992; see Table 1, footnote b). Finally, we created four classes for basal area such that each class contained 25% of our sample points, namely 0·09–11 $m^2\ ha^{-1}$, 11–16 $m^2\ ha^{-1}$, 16–25 $m^2\ ha^{-1}$ and > 25 $m^2\ ha^{-1}$.

Table 1. Reference forest structures that might affect goshawk reproduction or survival in ponderosa pine forests of the South-western United States. We hypothesized that goshawk reproduction would increase as a goshawk breeding area increasingly resembled the goshawk guidelines or preferred foraging habitat, but would decrease with increasing resemblance to presettlement conditions. Unless otherwise labelled, percentages are percentage of landscape area. VSS: Vegetative Structural Stages

	Description		
Forest structure	243-ha Central Zone	972-ha Foraging Band	Source
Goshawk guidelines I[a]	7% VSS class[b] 1; 7% VSS 2; 14% VSS 3; 14% VSS 4 with > 50% canopy closure; 58% VSS 5–6 with > 50% canopy closure ≥ 4·9 snags ha^{-1} and ≥ 7·4 logs ha^{-1}	10% each VSS[b] 1 and 2; 20% each VSS 4, 5, and 6 with > 40% canopy closure ≥ 4·9 snags ha^{-1} and ≥ 7·4 logs ha^{-1}	Reynolds *et al.* (1992)
Goshawk guidelines II[a,c]	VSS diameter distribution as above, but no requirements for canopy closure, snags, or logs		Reynolds *et al.* (1992)
Preferred foraging habitat	50[d] large (> 40·6 cm d.b.h.) trees ha^{-1} Canopy closure > 40%		Greenwald *et al.* (2005)
Pre-settlement conditions	2% VSS 1, 8% VSS 2, 14% VSS 3, 16% VSS 4, 28% VSS 5, 32% VSS 6 69% basal area < 11 $m^2\ ha^{-1}$, 14% basal area 11–16 $m^2\ ha^{-1}$, 11% basal area 16–25 $m^2\ ha^{-1}$, 5% basal area > 25 $m^2\ ha^{-1}$ 83% canopy closure < 40%, 10% canopy closure 40–60%, 7% canopy closure > 60%		Unweighted mean of frequency distributions for each variable in Fig. 1

[a]Central Zone prescription is the area-weighted average of Reynolds *et al.* (1992) prescriptions for the 73-ha nest areas and 170-ha post-fledging family area. [b]VSS 1: 0–3 cm d.b.h.; VSS 2: 3–13 cm d.b.h.; VSS 3: 13–30 cm d.b.h.; VSS 4: 30–46 cm d.b.h.; VSS 5: 46–61 cm d.b.h.; VSS 6: > 61 cm d.b.h. VSS of each plot is class with plurality of basal area, regardless of species. [c]Greenwald *et al.* 2005) and references cited therein did not specify an optimal number of large trees/ha, but all the studies cited therein suggested that the optimum was probably higher than any density we observed in a goshawk breeding area. Specified value (50) is 20% larger than the highest mean density we observed in a goshawk breeding area. The results of our analyses did not vary when we tried ideal values ranging up to 100 (an implausibly high value for this region). [d]Reduced model built to avoid the risk of spurious results due to: (a) calculated canopy closure classes could differ from true canopy classes, and (b) only small fractions of each breeding area met snag and log targets.

CALCULATING SIMILARITY OF BREEDING AREAS TO REFERENCE CONDITIONS

We used percentage similarity, S (Bray & Curtis 1957; Ludwig & Reynolds 1989) as an index of how each breeding area matched reference forest structures. S is scaled from 0% (no similarity) to 100% (complete similarity). Although designed originally to calculate similarity between communities or species assemblages, S can also be used to quantify similarity between sampling units and reference conditions that share a common set of descriptor variables. S is calculated as $2W/(A + B)$, where $W = \Sigma \min(X_i, X_r)$, $A = \Sigma X_i$ and $B = \Sigma X_r$. In our case the Xs were variables such as percentage of total area dominated by trees of a particular diameter class or with at least 4·9 large snags per ha. X_i values are the observed values in a goshawk breeding areas and X_r values are the value for the same variable under the reference condition.

We calculated how well each goshawk breeding area resembled each of four reference forest structures (Table 1), including two versions of the goshawk guidelines, an empirical estimate of presettlement forest structure and an estimate of preferred foraging habitat. Reynolds *et al.* (1992) developed the goshawk guidelines by identifying 14 goshawk prey species, reviewing the literature on habitat selection by these species, and interpreting the literature on habitat use by those 14 species in terms of six tree diameter class (Table 1, footnote b), canopy closure and numbers of snags and logs. This process yielded recommendations that nesting habitat should be dominated by trees > 46 cm d.b.h. with canopy closure > 50%, that the post-fledging family area should be dominated by the larger diameter classes with canopy closure > 50%, and the foraging area should be dominated by larger diameter classes with canopy closure > 40% (details in Table 1).

Our first model for the goshawk guidelines reflected the distribution of diameter classes, canopy closures, snags and logs recommended by Reynolds *et al.* (1992). The second version reflected only the distribution of diameter classes recommended by Reynolds *et al.* (1992). We developed this simpler model for two reasons. First, we did not measure canopy closure directly in the field, but calculated it using a Forest Service algorithm (US Forest Service 1993b), which introduced unknown errors into our estimates of canopy closure class. Secondly, most goshawk breeding areas had far fewer snags and logs than recommended by Reynolds *et al.* (1992), such that all goshawk breeding areas were about equally dissimilar from the goshawk guidelines with regard to these characteristics. This uniform dissimilarity could mask importance of differences among breeding areas in tree diameter distributions.

Our reference forest structure for preferred foraging habitat was based on interpretation of 12 studies of foraging habitat summarized by Greenwald *et al.* (2005). These studies suggest that ideal foraging habitat is a landscape with an average of 50 large trees ha^{-1} and 100% of the landscape with canopy closure > 40% (details in Table 1, footnote c).

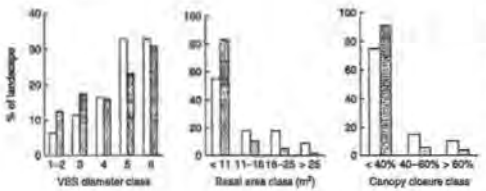

Fig. 1. Frequency distributions of Vegetative Structural Stage diameter classes, basal area classes and canopy closure classes in presettlement conditions at 79 plots near Grandview Point, Arizona (open bars, 250 km from our study area), and 143 plots near Mount Trumbull, Arizona (dark bars, 450 km from our study area). We used the unweighted mean of each pair to estimate presettlement conditions. Data provided by P. Z. Fulé (Northern Arizona University, unpublished).

Table 2. Alternative models of forest structure effects on goshawk reproduction, *F*. *S* refers to percentage similarity (Bray & Curtis 1957); subscripts CZ and FB refer to the Central Zone and Foraging Band, respectively, of a goshawk breeding area

Hypothesis	Model
Resemblance of CZ and FB to forest structure prescribed in the goshawk guidelines improves goshawk reproduction	$F = B_0 + B_1 \times S_{GG,CZ} + B_2 \times S_{GG,FB}$; B_1, $B_2 > 0$, where S_{GG} = similarity to Goshawk Guidelines I in Table 1
Resemblance of CZ to forest structure prescribed in the goshawk guidelines improves goshawk reproduction	$F = B_0 + B_1 \times S_{GG,CZ}$; $B_1 > 0$
Resemblance of CZ and FB to diameter distribution prescribed in the goshawk guidelines improves goshawk reproduction	$F = B_0 + B_1 \times S_{GGdiam,CZ} + B_2 \times S_{GGdiam,FB}$; B_1, $B_2 > 0$, where S_{GGdiam} = similarity to Goshawk Guidelines II in Table 1
Resemblance of CZ to diameter distribution prescribed in the goshawk guidelines improves goshawk reproduction	$F = B_0 + B_1 \times S_{GGdiam,CZ}$; $B_1 > 0$
Increased amount of preferred foraging habitat in CZ and FB improves goshawk reproduction	$F = B_0 + B_1 \times S_{PFH,CZ} + B_2 \times S_{PFH,FB}$; B_1, $B_2 > 0$, where S_{PFH} = similarity to preferred foraging habitat in Table 1
Increased amount of preferred foraging habitat in CZ improves goshawk reproduction	$F = B_0 + B_1 \times S_{PFH,CZ}$; $B_1 > 0$
Resemblance of CZ and FB to presettlement forest structure decreases goshawk reproduction	$F = B_0 + B_1 \times S_{presett,CZ} + B_2 \times S_{presett,FB}$; B_1 and $B_2 < 0$, where $S_{presett}$ = similarity to presettlement conditions in Table 1
Resemblance of CZ to presettlement forest structure decreases goshawk reproduction	$F = B_0 + B_1 \times S_{presett,CZ}$; $B_1 < 0$

Our reference forest structure for presettlement conditions was based on reconstructed conditions at two sites in Arizona, one near Grandview Point on the south rim of the Grand Canyon (Fulé *et al.* 2002) and one near Mount Trumbull (Waltz *et al.* 2003). In both cases, dendroecological methods (Fritts & Swetnam 1989) were applied to current evidence (old-growth trees, stumps, logs and other signs of tree removal) to estimate forest conditions prior to livestock grazing, fire suppression and logging (1870 at Mount Trumbull, 1887 at Grandview). P. Z. Fulé (Northern Arizona University) provided the raw data that we used to recreate frequency distributions of basal area, dominant diameter class and canopy closure (Fig. 1). These were the only available data on presettlement conditions in nearby ponderosa pine and pine–oak forests. Soil types in these two areas were derived from the same parent materials (basalt, calcareous sandstone and limestone) as those in our study area. Because the two sites had similar distributions for each variable measured, we used the mean of the two distributions as the reference condition.

EVALUATING EMPIRICAL SUPPORT FOR ALTERNATIVE MODELS

For each set of reference conditions, we built two models that related goshawk reproduction (number of fledglings fledged per year monitored) to the percentage similarity of a goshawk breeding area to that reference forest structure. One model related reproduction only to conditions in the Central Zone; the second model had an additional term for the influence of the Foraging Band (Table 2).

We used an information-theoretic approach adjusted for small sample size [Akaike's information criterion (AIC_c); Burnham & Anderson 2002] to evaluate empirical support for each of the eight models. Because this approach will always identify the model with the best support, even when no model is well supported, we report only models that met minimal thresholds of $\Delta AIC_c < 5{\cdot}0$ and adjusted $r^2 > 0{\cdot}10$. We compared empirical support among the eight models.

Results

The 13 goshawk breeding areas varied in their percentage similarity to reference forest structures (see Table S2 in Supplementary material). The Central Zones of breeding areas were on average 32% similar (range 21–56%) to the forest structure recommended by the goshawk guidelines. When only the diameter distribution recommended by the guidelines was considered, average percentage similarity increased to 50% (range 32–82%). The Foraging Band of a breeding area was somewhat more similar to the goshawk guidelines, averaging 43% similarity (range 26–57%) for the full prescription and 71% (range 53–85%) for the diameter distribution only. Percentage similarity between breeding areas and preferred foraging habitat averaged 65% in both the Central Zone and Foraging Band. Goshawk breeding areas were about 30% similar to presettlement conditions, with no Central Zone or Foraging Band exceeding 38% similarity.

Three of the four models relating goshawk reproduction to the goshawk guidelines were supported by the data (Table 3), including two models that included only effect of forest structure in the Central Zone, and one model that included effects of both the Central Zone and the Foraging Band. Contrary to expectation, however, goshawk breeding areas that resembled most closely the forest structure prescribed by the goshawk guidelines tended to have lower goshawk productivity (Table 3, Fig. 2). This negative influence was most pronounced for forest conditions in the Central Zone, for which a 1 standard deviation (SD) increase in percentage similarity was associated with a half SD decrease in productivity. The similarity of the Foraging Band to the goshawk guidelines had a negative association with goshawk productivity in only one model, but the coefficient was close to zero (Table 3). In light of these surprising results, we examined models for the three worst years of goshawk reproduction (1997, 2001 and 2002), as well as the three best years of goshawk reproduction (1995, 1996 and 1998; details in Table S1 of Supplementary material). In both cases the same models were supported, and the sign and size of standardized coefficients were similar to those observed across all 9 years. No r^2 value exceeded 45% (Table 3).

No model relating goshawk reproduction to ideal foraging habitat or to presettlement forest structure was supported by the data. Because our linear models could be insensitive to non-linear trends we examined scatterplots, which confirmed the lack of association between fledgling success and these two forest structures in either the Central Zone or Foraging Band.

Table 3. Models relating goshawk reproduction to the percentage similarity of a breeding area to a reference forest structure, for 13 goshawk breeding areas monitored 1993–2002 on the Apache-Sitgreaves National Forest, Arizona. Only models with $\Delta AIC_c < 5$ and $r^2 > 0{\cdot}10$ are shown. Eight models were tested

Model*	Reference forest structure	ΔAIC_c	r^2	Standardized coefficient CZ	Standardized coefficient FB
2	Goshawk guidelines	0·0	0·45	−0·67	NA
4	Diameter distribution of goshawk guidelines	1·3	0·39	−0·40	NA
1	Goshawk guidelines	4·3	0·45	−0·64	−0·04

*Model number from Table 2.

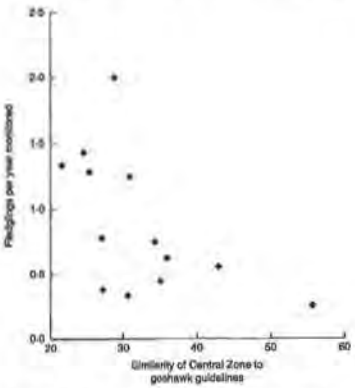

Fig. 2. Mean number of goshawk fledglings per year monitored decreased with increasing similarity to the goshawk guidelines for $n = 13$ territories monitored on the Apache-Sitgreaves National Forest, Arizona over 9 years ($r^2 = 0{\cdot}45$).

Discussion

A PRIORI HYPOTHESES

None of the expected associations between goshawk reproduction and forest structure were confirmed. There was no evidence of increased goshawk reproduction in breeding areas that resembled preferred foraging habitat, or of decreased reproduction in forest structure more similar to presettlement conditions.

The strongest pattern was that, contrary to our hypothesis, production of fledglings decreased as the breeding area's similarity to the goshawk guidelines increased. Why did goshawk reproduction not increase with similarity to the goshawk guidelines? One possibility is that Reynolds *et al.* (1992) estimated inaccurately forest conditions that maximize prey abundance. Their procedure involved three key decisions or interpretations, each of which was subject to uncertainty (Arizona Game and Fish Department 1993). First, Reynolds *et al.* (1992) gave each prey species equal weighting in their analysis, despite differences among prey species in biomass, abundance and contribution to goshawk diet, and despite the fact that six of the 14 species are unavailable in winter. Secondly, Reynolds *et al.* (1992) interpreted primary literature to estimate whether each species was found in low, moderate or high abundance in each VSS canopy closure class. These interpretations were necessarily subjective because the primary literature did not use VSS as an independent variable and because the three abundance classes were not defined explicitly. Thirdly, Reynolds *et al.* (1992) translated tallies of the number

of species scoring 'high' and 'medium' in each VSS class into optimal percentages of the landscape in each class. Although Reynolds *et al.* (1992) discussed and interpreted these tallies thoughtfully, others (e.g. Arizona Game and Fish Department 1993) interpreted these same data as supporting a prescription with larger fractions of the landscape dominated by larger trees and denser canopy closures. Errors at each step in the process could have synergistic effects that compromised this conceptual model.

Another possibility is that Reynolds *et al.* (1992) erred in their fundamental assumption that goshawks are habitat generalists and prey specialists that thrive best in a landscape with abundant prey. Drennan & Beier (2003) and Greenwald *et al.* (2005) questioned this assumption and emphasized evidence that goshawks are prey generalists and habitat specialists.

Finally, the goshawk guidelines use a forest descriptor (VSS) that has never been evaluated rigorously for its utility as a descriptor of wildlife habitat (although it was developed originally for this purpose: Thomas 1979). To the extent that VSS is an inappropriate descriptor it would contribute to statistical noise in our analyses, but such noise is unlikely to cause the negative correlation we observed.

Our results offer no support for the alternative hypothesis that reproductive success increases in breeding areas with increasing percentage of ideal foraging habitat. Empirical studies of foraging locations selected by goshawks in the western United States (summarized by Greenwald *et al.* 2005) were remarkably consistent in documenting that goshawks use forest structures characterized by relatively dense canopy and many large trees, but do not use sites with higher prey abundance. Goshawks in France also seem indifferent to prey abundance but partial to large trees and high crown volumes (Penteriani, Faivre & Frochot 2001). Because these forest conditions did not improve goshawk reproduction, we speculate that perhaps these forest conditions are associated positively with demographic parameters that we did not measure, such as reproductive life span, or adult or post-fledging survival.

Presettlement forest structure (< 250 stems ha^{-1}, < 40% canopy closure, < 1 large snag and < 1 large log per ha; Fulé *et al.* 2002; Waltz *et al.* 2003) differs markedly both from preferred habitat and from the recommendations of the goshawk guidelines. Thus we expected that similarity to this structure would be correlated negatively with goshawk reproduction. Our results do not support this notion. However, no goshawk breeding area was > 39% similar to restored conditions, and we caution against extrapolating our results to the effects of large-area restoration treatments.

The three forest structures we examined had only moderate influence on goshawk productivity. Two other studies, using different forest traits, found little influence of forest structure on reproductive success of northern goshawks in the western United States. Joy (2002) found that proportions of six vegetation types did not differ between 56 higher-productivity and 44 lower-productivity goshawk territories in a 9-year study in northern Arizona. Patla (1997) observed no effect of percentage mature forest on goshawk occupancy or goshawk productivity per occupied nest, and attributed this result to the fact that all territories had high (> 60%) percentage mature forest with little inter-territory variation. The most regularly occupied territories in her study were characterized by relatively greater proportions of mature forest cover. Patla (1997) also observed a small positive effect of sage-scrub openings on occupancy and reproduction (r^2 = 0·22) and speculated that prey production was relatively high in those openings.

The low correlations we observed may be related to the fact that our circular areas did not necessarily correspond to areas of most intense goshawk use. None the less, we believe the 1215-ha circular areas we sampled included most areas used by breeding goshawks parents and fledglings during the breeding season. On the nearby Coconino National forest, mean home range size (95% harmonic mean) during the breeding season was 840 ha for 23 females and 1341 ha for 12 males (Hall 2001). Similarly, our 880-m radius Central Zone probably includes areas most important to juveniles and adult females during the fledgling dependency period. Kennedy *et al.* (1994) reported that 96% of the locations of fledglings were within 800 m of the nest during the first 4 weeks of the juvenile dependency period, decreasing to 76% in the last 4 weeks. However, these home range areas are not circular, and goshawks use areas within their home range non-uniformly (Kennedy *et al.* 1994; Beier & Drennan 1997).

WHAT MAKES SOME GOSHAWK BREEDING AREAS MORE PRODUCTIVE THAN OTHERS?

Like Krüger & Lindström (2001), we observed that some goshawk breeding areas consistently produced more fledglings than others. The contrary findings of McClaren *et al.* (2002) may reflect their use of fledglings per active nest as the response variable, ignoring differences in occupancy rates among breeding areas. However, if forest structure does not drive productivity, what does? Plausible hypotheses include prey abundance, disturbance, weather patterns and parenting ability of goshawk breeders.

Prey abundance was correlated with year-to-year variation in reproduction for goshawk populations studied for 4–10 years in the western United States (Doyle & Smith 1994; Keane 1999; Salafsky, Reynolds & Noon 2005) and Sweden (Tornberg, Korpimäki & Byholm 2006), but was uncorrelated with goshawk population growth in a 24-year time-series in Germany (Krüger & Lindström 2001). Based on the three US studies, we believe that prey abundance is a major driver of year-to-year variation in reproduction for goshawk populations in the western United States. A reasonable hypothesis is that prey abundance also drives reproductive variation among goshawk breeding areas. To our knowledge, no study has tested this hypothesis.

Disturbance levels, such as number of roads, traffic volume on roads or trails, amount of residential development, timber harvest and research activity (e.g. nest checks, nest surveys) could also affect goshawk reproduction. These disturbances were relatively constant across our 13 breeding areas, but we believe that an unauthorized camping area did cause abandonment of one breeding area that had been consistently

productive before intensive camping began near the nest stand.

Weather patterns, such as spring and summer precipitation, are correlated with between-year variation in goshawk reproduction (Kostrzewa & Kostrzewa 1990; Patla 1997; Penteriani 1997; Ingraldi 1999; Bloxton 2002; Fairhurst & Bechard 2005). However, for such effects to account for variation among goshawk breeding areas, the breeding areas would have to experience different weather patterns. We do not believe this was the case on our study area.

Finally, our most productive breeding areas may have reflected qualities of the breeding pairs rather than forest structure within the breeding area. However, given a mean reproductive life span of 2 years (Wiens & Reynolds 2005), several generations of high-quality parents would have to use a given breeding area to create high productivity over 9 years of observations. Until a researcher devises a method to measure parenting ability independently from nest success, it would be difficult to design a study to test this hypothesis rigorously.

MANAGEMENT IMPLICATIONS

The goshawk guidelines were conceived as an approach to management that would address the needs of multiple species (goshawks and 14 prey species) and most other forest objectives (Reynolds *et al.* 1992). Compared to the years when production of fibre and ungulates drove forest management, the guidelines marked a big step towards ecosystem management and conservation of all native species. However, the assumptions behind the guidelines remain a set of largely untested hypotheses. Despite small sample size and the use of an observational rather than experimental approach, we found a moderate negative correlation between goshawk productivity and the forest structure prescribed by the guidelines. This calls into question the purported benefit to goshawks. Studies have not yet addressed response of the 14 prey species.

These results raise questions about the decision (US Forest Service 1996) to implement the goshawk guidelines on most Forest Service lands in Arizona and New Mexico. In (1993, the Arizona Game and Fish Department (1993: 62) recommended that the Forest Service 'identify areas... which reflect the desired future conditions identified in the [goshawk guidelines, and] ... monitor these areas to see if goshawks and the 14 targeted prey have responded as expected'. Our study suggests that goshawks did not respond as expected, and the monitoring and adaptive management approach recommended in 1993 is equally important today.

More broadly, many prescriptions for managing forests and other wildlands are based on ecological hypotheses. Managers should evaluate empirical support for the ecological hypotheses that are being applied to large landscapes. Careful allocation of areas to prescription and control sites, adequate replication and long-term monitoring are essential to evaluate empirical support in the most rigorous fashion. Observational studies such as ours can be a fast and relatively inexpensive alternative.

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References

Arizona Game and Fish Department (1993) Review of US Forest Service strategy for managing northern goshawk habitat in the southwestern United States. Unpublished report. Arizona Game and Fish Department, Phoenix, AZ.

Arizona Game and Fish Department (undated) *Wildlife of Special Concern in Arizona*. Arizona Game and Fish Department, Phoenix, AZ.

Beier, P. & Drennan, J.E. (1997) Forest structure and prey abundance in foraging areas of northern goshawks. *Ecological Applications*, 7, 564–571.

Bloxton, T.D. (2002) *Prey abundance, space use, demography, and foraging habitat of northern goshawks in western Washington*. Masters thesis, University of Washington.

Boal, C.W. (1994) A photographic and behavioral guide to aging nestling northern goshawks. *Studies in Avian Biology*, 16, 97–102.

Bray, J.R. & Curtis, J.T. (1957) An ordination of the upland forest communities of southern Wisconsin. *Ecological Monographs*, 27, 325–349.

Burnham, K.P. & Anderson, D.R. (2002) *Model Selection and Multimodel Inference: a Practical Information-Theoretic Approach*, 2nd edn. Springer, New York.

Covington, W.W. & Moore, M.M. (1994) Southwestern ponderosa forest structure: changes since Euro-American settlement. *Journal of Forestry*, 92, 39–47.

Crocker-Bedford, D.C. (1990) Goshawk reproduction and forest management. *Wildlife Society Bulletin*, 18, 262–269.

Crocker-Bedford, D.C. (1995) Northern goshawk reproduction and forest management. *Journal of Raptor Research*, 29, 42–43.

Doyle, F.I. & Smith, J.N.M. (1994) Population responses of northern goshawks to the 10-year cycle in numbers of snowshoe hares. *Studies in Avian Biology*, 16, 122–129.

Drennan, J.E. & Beier, P. (2003) Forest structure and prey abundance in winter habitat of northern goshawks. *Journal of Wildlife Management*, 67, 177–185.

Eyre, F.H. (1981) *Forest Cover Types of the United States and Canada*. Society of American Foresters, Bethesda, MD.

Fairhurst, G.D. & Bechard, M.J. (2005) Rufous/white harvest winter and spring weather and northern goshawk (*Accipiter gentilis*) reproduction in northern Nevada. *Journal of Raptor Research*, 39, 229–236.

Finn, S.P., Marzluff, J.M. & Varland, D.E. (2002) Effects of landscape and local habitat attributes on northern goshawk site occupancy in western Washington. *Forest Science*, 48, 427–436.

Fritts, H.C. & Swetnam, T.W. (1989) Dendroecology: a tool for evaluating variations in past and present forest environments. *Advances in Ecological Research*, 19, 111–188.

Fulé, P.Z., Covington, W.W. & Moore, M.M. (1997) Determining reference conditions for ecosystem management of southwestern ponderosa pine forests. *Ecological Applications*, 7, 895–908.

Fulé, P.Z., Covington, W.W., Smith, H.B., Springer, J.D., Heinlein, T.A., Huisinga, K.D. & Moore, M.M. (2002) Testing ecological restoration alternatives: Grand Canyon, Arizona. *Forest Ecology and Management*, 170, 19–41.

Greenwald, D.N., Crocker-Bedford, D.C., Broberg, L., Suckling, K.F. & Tibbitts, T. (2005) A review of northern goshawk habitat selection in the home range and implications for forest management in the western United States. *Wildlife Society Bulletin*, 33, 120–129.

Hall, P.A. (2001) *Size and composition of northern goshawk (Accipiter gentilis) home ranges in north-central Arizona*. PhD thesis, Northern Arizona University.

Ingraldi, M.F. (1999) *Population biology of northern goshawks (Accipiter gentilis) in east-central Arizona*. PhD thesis, Northern Arizona University.

Joy, S.M. (2002) *Northern goshawk habitat on the Kaibab National Forest, Arizona: factors affecting nest locations and territory quality*. PhD thesis, Colorado State University.

Joy, S.M., Reynolds, R.T. & Leslie, D.G. (1994) Northern goshawk broadcast surveys: hawk response variables and survey cost. *Studies in Avian Biology*, **16**, 3–11.
Keane, J.J. (1999) *Ecology of the northern goshawks in the Sierra Nevada, California*. PhD thesis, University of California Davis.
Kennedy, P.L. (1997) The northern goshawk (*Accipiter gentilis atricapillus*): is there evidence of a population decline? *Journal of Raptor Research*, **31**, 95–106.
Kennedy, P.L. & Stahlecker, D.W. (1993) Responsiveness of nesting northern goshawks to taped broadcasts of 3 conspecific calls. *Journal of Wildlife Management*, **57**, 249–257.
Kennedy, P.L., Ward, J.M., Rinker, G.A. & Gessman, J.A. (1994) Post-fledging areas in northern goshawk home ranges. *Studies in Avian Biology*, **16**, 57–82.
Kostrzewa, A. & Kostrzewa, R. (1990) The relationship of spring and summer weather with density and breeding performance of the buzzard (*Buteo buteo*), goshawk (*Accipiter gentilis*) and kestrel (*Falco tinnunculus*). *Ibis*, **132**, 550–559.
Krüger, O. & Lindström, J. (2001) Habitat heterogeneity affects population growth in goshawk *Accipiter gentilis*. *Journal of Animal Ecology*, **70**, 173–181.
Long, J.N. (1985) A practical approach to density management. *Forest Chronicle*, **61**, 23–27.
Ludwig, J.A. & Reynolds, J.F. (1988) *Statistical Ecology*. Wiley and Sons, New York.
Mast, J.N., Fulé, P.Z., Moore, M.M., Covington, W.W. & Waltz, A.E.M. (1999) Restoration of pre-settlement age structure of an Arizona ponderosa pine forest. *Ecological Applications*, **9**, 228–239.
McClaren, E.L., Kennedy, P.L. & Dewey, S.R. (2002) Do some northern goshawk nest areas consistently fledge more young than others? *Condor*, **104**, 343–352.
McTague, J.P. & Patton, D.R. (1989) Stand density index and its application in describing wildlife habitat. *Wildlife Society Bulletin*, **17**, 58–62.
Patla, S.M. (1997) *Nesting ecology and habitat of the northern goshawk in undisturbed and timber harvest areas on the Targhee National Forest, Greater Yellowstone Ecosystem*. Masters thesis, Idaho State University.
Penteriani, V. (1997) Long-term study of a goshawk breeding population on a Mediterranean mountain (Abruzzi Apennines, central Italy): density, breeding performance, and diet. *Journal of Raptor Research*, **31**, 308–312.
Penteriani, V., Falvo, R. & Prochot, B. (2001) An approach to identify factors and levels of nesting habitat selection: across-scale analysis of goshawk preferences. *Ornis Fennica*, **78**, 159–167.
Reynolds, R.T., Graham, R.T., Reiser, M.H., Bassett, R.L., Kennedy, P.L., Boyce, D.A., Goodwin, G., Smith, R. & Fisher, E.L. (1992) *Management Recommendations for the Northern Goshawk in the Southwestern United States*. General Technical Report RM-217. US Forest Service Southwest Region, Albuquerque, New Mexico.
Salafsky, S.R., Reynolds, R.T. & Noon, B.R. (2005) Patterns of temporal variation in goshawk reproduction and prey resources. *Journal of Raptor Research*, **39**, 238–246.
Steenhof, K. (1987) Assessing raptor reproductive success and productivity. *Raptor Management Techniques Manual* (eds B.A. Pendleton, B.A. Milsap, K.W. Kline & D.M. Bird), pp. 157–170. National Wildlife Federation, Washington, DC.
Thomas, J.W. (1979) *Wildlife Habitats in Managed Forests: the Blue Mountains of Oregon and Washington*. US Forest Service Agricultural Handbook 553. US Government Printing Office, Washington, DC.
Tornberg, R., Korpimäki, E. & Byholm, P. (2006) Ecology of the northern goshawk in Fennoscandia. *Studies in Avian Biology*, **31**, 141–157.
US Fish and Wildlife Service (1995) *Recovery Plan for the Mexican Spotted Owl*. U.S. Fish & Wildlife Service, Albuquerque, New Mexico.
US Fish and Wildlife Service (1998) *Northern Goshawk Status Review*. Office of Technical Support, Portland.
US Forest Service (1993a) *Forest Service Manual 2670*. Interim Directive no. R3, 2670-2693-1. US Forest Service, Albuquerque.
US Forest Service (1993b) *Standard Specifications for Stand Exam, Rocky Mountain Region, Southwest Region, Intermountain Region*. Government Printing Office, Albuquerque, New Mexico.
US Forest Service (1995) *Final Environmental Impact*. Statement for Amendment of Forest Plans. US Forest Service Southwestern Region, Albuquerque.
US Forest Service (1996) *Record of Decision for Amendment of Forest Plans*. Southwestern Region, Albuquerque.
Waltz, A.E.M., Fulé, P.Z., Covington, W.W. & Moore, M.M. (2003) Diversity in ponderosa pine forest structure following ecological restoration treatments. *Forest Science*, **49**, 885–900.
Ward, L.Z., Ward, D.K. & Tibbitts, T.J. (1992) *Canopy Density at Goshawk Nesting Territories on the North Kaibab Ranger District, Kaibab National Forest*. Arizona Game and Fish Department Non-game and Endangered Wildlife Program, Phoenix, Arizona.
Wiens, J.D. & Reynolds, R.T. (2005) Is fledgling success a reliable index of fitness in northern goshawks? *Journal of Raptor Research*, **39**, 210–221.
Woodbridge, B. & Detrie, P.J. (1994) Territory occupancy and habitat patch size of northern goshawks in the southern Cascades of California. *Studies in Avian Biology*, **16**, 83–87.

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Supplementary material

The following supplementary material is available for this article.

Table S1. Reproductive history of the 13 goshawk breeding areas 1993–2002.

Table S2. Percentage similarity to reference conditions and productivity for the 13 goshawk breeding areas.

This material is available as part of the online article from: http://www.blackwell-synergy.com/doi/full/10.1111/j.1365-2664.2007.01409.x
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Does forest structure affect reproduction of northern goshawks in ponderosa pine forests?

Paul Beier[1]*, Erik C. Rogan[1], Michael F. Ingraldi[2] and Steven S. Rosenstock[2]

[1]*School of Forestry and Merriam-Powell Center for Environmental Research, Northern Arizona University, Flagstaff AZ 86011, USA; and* [2]*Arizona Game and Fish Department, 2221 West Greenway Road, Phoenix, AZ 85023, USA*

Summary

1. Many management prescriptions are based on ecological hypotheses; evaluating empirical support for these hypotheses can improve management. There has been considerable dispute about the potential response of the northern goshawk to three management-driven forest structures in ponderosa pine forests of the south-western United States: (i) the structure recommended by US Forest Service's goshawk guidelines, designed to increase the abundance of 14 goshawk prey species and thus benefit goshawks; (ii) preferred foraging habitat as suggested by empirical evidence that goshawks forage selectively in areas with abundant large trees and dense canopy closure, rather than areas of highest prey abundance; and (iii) presettlement (i.e. prior to Euro-American settlement) structure characterized by clumps of large trees, canopy closure < 40% and dense herbaceous understorey, which could have negative effects on goshawks.
2. To evaluate empirical support for hypotheses that goshawk reproduction is affected by each of these three forest structures, we measured forest structure in a 1215-ha nest-centred circular area in each of 13 goshawk breeding areas on the Apache–Sitgreaves National Forest, Arizona. The breeding areas were selected to span the full range of productivity (fledglings per year monitored) over the previous 9-year period.
3. Forest structure had a moderate effect on goshawk productivity ($r^2 \leq 0{\cdot}46$). Contrary to expectation, goshawk productivity decreased with increasing similarity to the goshawk guidelines.
4. Goshawk reproduction was not correlated with resemblance of the breeding area to preferred foraging habitat or resemblance to presettlement forest conditions.
5. *Synthesis and applications*. Because the goshawk guidelines may not improve goshawk reproduction, the Forest Service should reconsider its decision to apply the guidelines to most forested lands in Arizona and New Mexico. Managers should evaluate empirical support routinely for the major ecological hypotheses that underlie forest prescriptions.

Key-words: *Accipiter gentilis*, ecological restoration, forest management, forest structure, *Pinus ponderosa*, reproductive success, vegetative structural stage

Introduction

The northern goshawk *Accipiter gentilis* L. is a species of concern in Arizona (Arizona Game and Fish Department, undated) and a US Forest Service sensitive species in Region 3 (US Forest Service 1993a). The goshawk population in the western United States was evaluated for listing under the Endangered Species Act in 1992 and 1998 (US Fish & Wildlife Service 1998). Concern over the status of the goshawk prompted the US Forest Service to develop management recommendations for National Forests in Arizona and New Mexico (Reynolds *et al.* 1992; referred to hereafter as 'goshawk guidelines'). In 1996, the goshawk guidelines were incorporated into amendments of all Forest Plans in these two states (US Forest Service 1995, 1996). The amendments require the goshawk guidelines to be implemented on all Forest Service forestlands that are not managed for Mexican spotted owls (*Strix occidentalis lucida*). A fundamental assumption of the goshawk guidelines is that the 'goshawk is a forest habitat generalist that uses a variety of forest types, forest ages, structural conditions, and successional stages' (Reynolds *et al.* 1992: 1). Reasoning that 'if goshawk populations are a barometer of their prey populations, then forest management should feature prey habitats', Reynolds *et al.* (1992) prescribed a forest structure that

*Correspondence author. E-mail: paul.beier@nau.edu

should provide abundant populations of 14 prey species. Following Reynolds *et al.* (1992), we use the term forest structure to include descriptors such as tree density, diameter distribution, canopy closure, numbers of snags and logs and basal area.

Greenwald *et al.* (2005) provide an alternative concept of ideal goshawk habitat. Their review of habitat use studies in North America (11 of 12 published after the goshawk guidelines) suggests that goshawk foraging locations within their home ranges are characterized by many large [> 40·6 cm diameter at breast height (d.b.h.)] trees and dense (> 40%) canopy closure, but that goshawks do 'not select stands with the greatest prey abundance' (Greenwald *et al.* 2005: 120). Although none of the studies reviewed by Greenwald *et al.* (2005) hypothesized that goshawk reproduction or survival would be highest in goshawk breeding areas with many large trees and dense canopy closure, this is a reasonable hypothesis from these observations.

In these same south-western forests, ecological restoration of ponderosa pine (*Pinus ponderosa*) and pine-oak (*Quercus* species) forests has been proposed to reverse changes to forest structure and function caused by a century of livestock grazing, fire suppression and timber harvest, and to reduce the risk of stand-replacing wildfires (Covington & Moore 1994). Accordingly, managers in the region are proposing treatments to restore conditions that prevailed prior to Euro-American settlement. Compared to current forest structure, these presettlement conditions are characterized by lower basal area, stem density and canopy closure, and a larger fraction of the landscape dominated by large trees (Fulé, Covington & Moore 1997; Mast *et al.* 1999; Fulé *et al.* 2002; Waltz *et al.* 2003). Concern that presettlement forest structure will affect goshawk populations adversely is one of the main issues raised by environmental advocacy groups opposed to implementation of restoration treatments (US Fish and Wildlife Service 1998).

Managers would benefit from an empirical assessment of how these three alternative forest structures would affect goshawks. Although direct experiments would be ideal, managers would have to assign randomly a statistically useful number of goshawk territories to required treatments and controls, and it would take decades to implement treatments and monitor goshawk response. We chose a less direct but more expedient approach by correlating goshawk reproduction with similarity of goshawk breeding areas to each of these three alternative forest structures.

Several previous studies have related stand characteristics to goshawk reproduction (Crocker-Bedford 1990, 1995; Ward, Ward & Tibbets 1992; Patla 1997; Finn, Marzluff & Farland 2002). Although each of these studies provided useful information about how reproduction varies with one or more forest trait, no study addressed these particular forest structures directly or compared empirical support for alternative hypotheses. Furthermore, these studies were limited to relatively short monitoring periods: 3–7 years per territory (Patla 1997) or 1–3 years per territory (all other studies). Monitoring reproduction for > 3 years is appropriate because goshawk reproduction in western North American landscapes fluctuates widely among years, probably driven by changes in weather and prey abundance (Kennedy 1997; Krüger & Lindström 2001; McClaren, Kennedy & Dewey 2002). One possibility is that forest structure affects reproduction only during years of high fledging success, other years being so poor that the influence of habitat is obscured. For example, Bloxton (2002) observed that goshawk reproduction virtually ceased in La Niña years (years of low precipitation in western North America driven by cold ocean temperatures in the equatorial Pacific), overriding habitat effects. Alternatively, forest structure might influence reproduction only in years of poor reproduction; for example, Krüger & Lindström (2001) observed that in good years all goshawk territories had high productivity with little variation among breeding areas.

To address these issues, we related goshawk nest productivity over a 9-year period to forest structure in landscapes around 13 goshawk breeding areas in ponderosa pine and pine–oak forests on the Apache–Sitgreaves National Forest in Arizona. Our objective was to assess how reproductive success of goshawks varied with similarity of goshawk breeding areas to three alternative forest structures (goshawk guidelines, preferred foraging habitat, presettlement conditions) over a time span that included a range of climatic conditions typical of the South-western United States.

Methods

STUDY AREA

We studied goshawks on the Black Mesa and Lakeside Ranger Districts of the Apache–Sitgreaves National Forest in east-central Arizona. The study area is part of the Mogollon Plateau, an area dominated by basaltic and limestone type soils that forms the uplifted southern edge of the Colorado Plateau and is dominated by ponderosa pine. Elevations in the study area ranged from 1768 to 2417 m (mean 2134 m). In these breeding areas, silverleaf oak (*Q. arizonica*), pinyon pine (*P. edulis*), alligator juniper (*Juniperus deppeana*) and Utah juniper (*J. osteosperma*) frequently co-occurred with ponderosa pine, especially at lower elevations or on south-facing slopes. At higher elevations and in steep canyons, co-dominant species were Douglas fir (*Pseudotsuga menziesii*), white fir (*Abies concolor*), and aspen (*Populus tremuloides*). Gambel oak (*Q. gambelii*) and New Mexico locust (*Robinia neomexicana*) were common understorey tree species throughout. Annual precipitation at the nearest weather station (Show Low Airport, 2102 m elevation) averaged 39·9 cm during 1993–2002, with driest years in 2002 (24·5 cm) and 1996 (31·4 cm), and relatively wet years in 1993 (53·4 cm), 1994 (50·7 cm) and 1997 (46·6 cm).

Our research activities occurred within a 1215-ha circle (radius 1967 m) from the geographical centroid of each area's known nest locations. To avoid the implication that these circles correspond exactly to goshawk territories, we use the term 'goshawk breeding areas' to refer to these circular areas.

None of the goshawk breeding areas in our study experienced timber harvest in > 8% of the breeding area (mean 2·8%, range 0–7·6%) during 1993–2002. Thus we believe that the goshawk reproduction we observed was not affected by disturbance or other short-term effects of timber harvest.

MONITORING GOSHAWK REPRODUCTION

During 1993–2002, the Arizona Game and Fish Department, US Forest Service (USFS) and Northern Arizona University collaborated to monitor northern goshawks in the study area. Each year, we first visited each historic northern goshawk breeding area in April and May to determine occupancy and locate any active nest. An historic breeding area was a nest site or cluster of nests where an incubating goshawk was observed at least once during the previous 3 years. If occupancy was not confirmed at historic nest sites, we conducted visual searches within a 1·6 km radius around the centroid of known nests, excluding pinyon–juniper woodlands, meadows or other treeless areas. Following USFS South-western Region's northern goshawk inventory protocols (Kennedy & Stahlecker 1993; Joy, Reynolds & Leslie 1994), we also broadcast conspecific recordings to elicit responses from northern goshawks. Playback tapes provided by the USFS included both the adult 'alarm' call and the female 'wail' call. The alarm call was used from June to early July (nestling period) and the wail call was used from late July to early September (fledgling period). Because Woodbridge & Detrich (1994) found 95% of alternative nests within 800 m of the last known nest, we placed 24 calling points uniformly throughout an 800-m radius area around previous nest sites. If we could not verify nesting activity in an occupied area early in the season, we conducted a second survey during the fledgling dependency period (August). We spent up to 7 person-days searching a breeding area before considering it unoccupied.

An area was considered occupied if a pair of goshawks were inferred to use the area during at least part of the breeding season, based on presence of a new or refurbished nest, an adult bird at or near a nest on ≥ 2 occasions, or fresh mutes, moulted feathers and prey remains around a nest structure (Ingraldi 1999). A nest was considered active if we observed a female goshawk in incubation posture, at least one fresh egg or egg shell fragments or fledgling or juvenile northern goshawks (Ingraldi 1999). Active nests were visited at least once every 10 days to monitor status and productivity.

A nest was deemed successful if at least one nestling survived to 100% of fledgling age (39 days old; Steenhof 1987). Ages were determined using Boal's (1994) photographic guide, or by the observed number of days since hatching. Productivity was measured as number of nestlings that survived at least 39 days, unless there was subsequent evidence that the nestlings did not fledge.

We used fledglings per year monitored (occupancy rate times productivity per occupied nest) as a measure of reproductive success. Nest productivity is a problematic measure because it considers only nest areas where pairs are present and initiate breeding but ignores intermittent use or early abandonment of lower quality sites (McClaren *et al.* 2002). Krüger & Lindström (2001) found that breeding pairs of goshawks occupied progressively poorer breeding sites as number of breeding pairs increased, i.e. only the best sites were occupied in years with few nesting attempts. Fledglings per year monitored incorporates both measures. Similarly, Wiens & Reynolds (2005: 210) found that the number of fledglings produced per adult goshawk over a 10-year period was 'a reliable index of fitness' (which they defined as recruitment to the breeding population). We did not use data for the first year each breeding area was discovered because by definition an area with a newly discovered nest could not be classified as unoccupied.

From all 46 goshawk breeding areas known and monitored annually for all or part of 1993–2002, we excluded 18 breeding areas because > 50% of the breeding area was dominated by either pinyon–juniper or mixed conifer vegetation types and four breeding areas at which major disturbance (campground construction, timber harvest in > 10% of the area during the 10-year period) occurred during the monitoring period. Because most goshawks in this region nest in forests dominated by ponderosa pine, we confined our attention to breeding areas in that forest type. We then selected the five most productive and five least productive breeding areas, and selected three areas randomly with intermediate productivity. For these 13 areas, we calculated fledglings produced per breeding area (see Table S1 in Supplementary material).

MEASURING FOREST STRUCTURE

After the 10 years of monitoring, when all nest locations had been determined, we measured forest structure in each of the 13 breeding areas. We mapped one sample point per 4·05 ha (10 acres) throughout each breeding area (~300 points per breeding area), assigned each point a Universal Transverse Mercator (UTM) location, and used global positioning system (GPS) units to locate each point on the ground.

Based on radio-telemetry studies, Reynolds *et al.* (1992) posited three key components to a goshawk home range: nest areas (73 ha divided among three alternate nest areas and three replacement areas); a post-fledging family area (170 ha near the nest used by the female and fledglings from incubation through juvenile dispersal); and a foraging area (2185 ha of additional foraging area for the male goshawk). Areas close to the nest may have a different influence on goshawk reproduction than do more distant areas. Thus we evaluated forest structure in two areas: a circular area centred on the geographical centroid of the breeding area's nest locations, and a larger annulus around this circle. The 243-ha circle (radius 880 m, ~60 sample points) was intended to encompass the nest areas and post-fledging family area; for brevity we refer to this circle as the Central Zone of a goshawk breeding area. The annulus was the area within a circle of radius 1967 m, excluding the Central Zone, and thus encompassed 972 ha (~240 sample points) of the foraging area closest to the nest; we refer to this area as the Foraging Band. Totalling 1215 ha, these areas represent half of a 2430-ha home range for a pair of breeding goshawks (Reynolds *et al.* 1992; Kennedy *et al.* 1994). Funding limitations precluded sampling additional breeding areas, or the entire foraging area.

We collected forest stand data at each point, using USFS intensive (Level I) stand examination procedures (US Forest Service 1993b). At each sample point we placed three concentric plots: (1) variable-radius plot utilizing a 10 basal area factor (BAF) prism within which we recorded d.b.h., height and species for each live tree; (2) 0·405-ha (1-acre) circular plot within which we tallied all snags > 25·4 cm d.b.h. and logs > 25·4 cm at midpoint; and (3) a 0·00405-ha (0·01-acre) fixed circular plot within which we tallied all seedlings and saplings < 12·7 cm d.b.h. Our minimum size thresholds for tallying snags and logs correspond to snag and log definitions in Reynolds *et al.* (1992).

After calculating basal area by species, we used USFS algorithms to calculate three derived variables at each point: forest type, canopy closure class and dominant diameter class. We recognized 10 forest types [non-forest, ponderosa pine, oak, pinyon–juniper (PJ), aspen, mixed conifer, pine–oak, pine–PJ, oak–PJ and PJ–oak] based on the basal area of each tree species with respect to thresholds defined by Eyre (1981) and US Fish and Wildlife Service (1995: 52–58). We estimated canopy closure class from percentage of a theoretical maximum Stand Density Index (SDI) for each forest type using the USFS algorithm (McTague & Patton 1989; US Forest Service 1993b) and maximum SDI values for each forest type proposed by Long (1985). Canopy closure class boundaries were 40% canopy closure (corresponding to 30% maximum SDI), 50% canopy closure

Table 1. Reference forest structures that might affect goshawk reproduction or survival in ponderosa pine forests of the South-western United States. We hypothesized that goshawk reproduction would increase as a goshawk breeding area increasingly resembled the goshawk guidelines or preferred foraging habitat, but would decrease with increasing resemblance to presettlement conditions. Unless otherwise labelled, percentages are percentage of landscape area. VSS: Vegetative Structural Stages

	Description		
Forest structure	243-ha Central Zone	972-ha Foraging Band	Source
Goshawk guidelines I[a]	7% VSS class[b] 1; 7% VSS 2; 14% VSS 3; 14% VSS 4 with > 50% canopy closure; 58% VSS 5–6 with > 50% canopy closure ≥ 4·9 snags ha^{-1} and ≥ 7·4 logs ha^{-1}	10% each VSS[b] 1 and 2; 20% each VSS 4, 5, and 6 with > 40% canopy closure ≥ 4·9 snags ha^{-1} and ≥ 7·4 logs ha^{-1}	Reynolds *et al.* (1992)
Goshawk guidelines II[a,d]	VSS diameter distribution as above, but no requirements for canopy closure, snags, or logs		Reynolds *et al.* (1992)
Preferred foraging habitat	30 large (> 40·6 cm d.b.h.) trees ha^{-1} Canopy closure > 40%		Greenwald *et al.* (2005)
Pre-settlement conditions	2% VSS 1, 8% VSS 2, 14% VSS 3, 16% VSS 4, 28% VSS 5, 32% VSS 6 69% basal area < 11 m^2 ha^{-1}, 14% basal area 11–16 m^2 ha^{-1}, 11% basal area 16–25 m^2 ha^{-1}, 5% basal area > 25 m^2 ha^{-1} 83% canopy closure < 40%, 10% canopy closure 40–60%, 7% canopy closure > 60%		Unweighted mean of frequency distributions for each variable in Fig. 1

[a]Central Zone prescription is the area-weighted average of Reynolds *et al.* (1992) prescriptions for the 73-ha nest areas and 170-ha post-fledging family area. [b]VSS 1: 0–3 cm d.b.h.; VSS 2: 3–13 cm d.b.h.; VSS 3: 13–30 cm d.b.h.; VSS 4: 30–46 cm d.b.h.; VSS 5: 46–61 cm d.b.h.; VSS 6: > 61 cm d.b.h. VSS of each plot is class with plurality of basal area, regardless of species. [c]Greenwald *et al.* (2005) and references cited therein did not specify an optimal number of large trees/ha, but all the studies cited therein suggested that the optimum was probably higher than any density we observed in a goshawk breeding area. Specified value (30) is 20% larger than the highest mean density we observed in a goshawk breeding area. The results of our analyses did not vary when we tried ideal values ranging up to 100 (an implausibly high value for this region). [d]Reduced model built to avoid the risk of spurious results due to: (a) calculated canopy closure classes could differ from true canopy classes, and (b) only small fractions of each breeding area met snag and log targets.

(corresponding to 39% of maximum SDI) and 60% (corresponding to 47% maximum SDI). We recognized six diameter classes, designated 1–6, corresponding to the Vegetative Structural Stages (VSS) used in USFS Region 3 (Reynolds *et al.* 1992; see Table 1, footnote b). Finally, we created four classes for basal area such that each class contained 25% of our sample points, namely 0·09–11 m^2 ha^{-1}, 11–16 m^2 ha^{-1}, 16–25 m^2 ha^{-1} and > 25 m^2 ha^{-1}.

CALCULATING SIMILARITY OF BREEDING AREAS TO REFERENCE CONDITIONS

We used percentage similarity, S (Bray & Curtis 1957; Ludwig & Reynolds 1989) as an index of how each breeding area matched reference forest structures. S is scaled from 0% (no similarity) to 100% (complete similarity). Although designed originally to calculate similarity between communities or species assemblages, S can also be used to quantify similarity between sampling units and reference conditions that share a common set of descriptor variables. S is calculated as $2W/(A + B)$, where $W = \Sigma \min(X_i, X_k)$, $A = \Sigma X_i$ and $B = \Sigma X_k$. In our case the Xs were variables such as percentage of total area dominated by trees of a particular diameter class or with at least 4·9 large snags per ha. X_i values are the observed values in a goshawk breeding areas and X_k values are the value for the same variable under the reference condition.

We calculated how well each goshawk breeding area resembled each of four reference forest structures (Table 1), including two versions of the goshawk guidelines, an empirical estimate of presettlement forest structure and an estimate of preferred foraging habitat. Reynolds *et al.* (1992) developed the goshawk guidelines by identifying 14 goshawk prey species, reviewing the literature on habitat selection by these species, and interpreting the literature on habitat use by these 14 species in terms of six tree diameter class (Table 1, footnote b), canopy closure and numbers of snags and logs. This process yielded recommendations that nesting habitat should be dominated by trees > 46 cm d.b.h. with canopy closure > 50%, that the post-fledging family area should be dominated by the larger diameter classes with canopy closure > 50%, and the foraging area should be dominated by larger diameter classes with canopy closure > 40% (details in Table 1).

Our first model for the goshawk guidelines reflected the distribution of diameter classes, canopy closures, snags and logs recommended by Reynolds *et al.* (1992). The second version reflected only the distribution of diameter classes recommended by Reynolds *et al.* (1992). We developed this simpler model for two reasons. First, we did not measure canopy closure directly in the field, but calculated it using a Forest Service algorithm (US Forest Service 1993b), which introduced unknown errors into our estimates of canopy closure class. Secondly, most goshawk breeding areas had far fewer snags and logs than recommended by Reynolds *et al.* (1992), such that all goshawk breeding areas were about equally dissimilar from the goshawk guidelines with regard to these characteristics. This uniform dissimilarity could mask importance of differences among breeding areas in tree diameter distributions.

Our reference forest structure for preferred foraging habitat was based on interpretation of 12 studies of foraging habitat summarized by Greenwald *et al.* (2005). These studies suggest that ideal foraging habitat is a landscape with an average of 50 large trees ha^{-1} and 100% of the landscape with canopy closure > 40% (details in Table 1, footnote c).

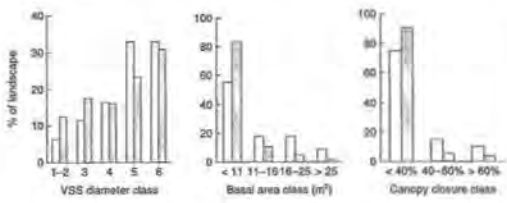

Fig. 1. Frequency distributions of Vegetative Structural Stage diameter classes, basal area classes and canopy closure classes in presettlement conditions at 79 plots near Grandview Point, Arizona (open bars, 250 km from our study area), and 143 plots near Mount Trumbull, Arizona (dark bars, 450 km from our study area). We used the unweighted mean of each pair to estimate presettlement conditions. Data provided by P. Z. Fulé (Northern Arizona University, unpublished).

Table 2. Alternative models of forest structure effects on goshawk reproduction. F, S refers to percentage similarity (Bray & Curtis 1957); subscripts CZ and FB refer to the Central Zone and Foraging Band, respectively, of a goshawk breeding area

Hypothesis	Model
Resemblance of CZ and FB to forest structure prescribed in the goshawk guidelines improves goshawk reproduction	$F = B_0 + B_1 \times S_{\text{GG1,CZ}} + B_2 \times S_{\text{GG1,FB}}$; B_1, $B_2 > 0$, where S_{GG1} = similarity to Goshawk Guidelines I in Table 1
Resemblance of CZ to forest structure prescribed in the goshawk guidelines improves goshawk reproduction	$F = B_0 + B_1 \times S_{\text{GG1,CZ}}$; $B_1 > 0$
Resemblance of CZ and FB to diameter distribution prescribed in the goshawk guidelines improves goshawk reproduction	$F = B_0 + B_1 \times S_{\text{GGdiam,CZ}} + B_2 \times S_{\text{GGdiam,FB}}$; B_1, $B_2 > 0$, where S_{GGdiam} = similarity to Goshawk Guidelines II in Table 1
Resemblance of CZ to diameter distribution prescribed in the goshawk guidelines improves goshawk reproduction	$F = B_0 + B_1 \times S_{\text{GGdiam,CZ}}$; $B_1 > 0$
Increased amount of preferred foraging habitat in CZ and FB improves goshawk reproduction	$F = B_0 + B_1 \times S_{\text{PFH,CZ}} + B_2 \times S_{\text{PFH,FB}}$; B_1, $B_2 > 0$, where S_{PFH} = similarity to preferred foraging habitat in Table 1
Increased amount of preferred foraging habitat in CZ improves goshawk reproduction	$F = B_0 + B_1 \times S_{\text{PFH,CZ}}$; $B_1 > 0$
Resemblance of CZ and FB to presettlement forest structure decreases goshawk reproduction	$F = B_0 + B_1 \times S_{\text{presett,CZ}} + B_2 \times S_{\text{presett,FB}}$; B_1 and $B_2 < 0$, where S_{presett} = similarity to presettlement conditions in Table 1
Resemblance of CZ to presettlement forest structure decreases goshawk reproduction	$F = B_0 + B_1 \times S_{\text{presett,CZ}}$; $B_1 < 0$

Our reference forest structure for presettlement conditions was based on reconstructed conditions at two sites in Arizona, one near Grandview Point on the south rim of the Grand Canyon (Fulé *et al.* 2002) and one near Mount Trumbull (Waltz *et al.* 2003). In both cases, dendroecological methods (Fritts & Swetnam 1989) were applied to current evidence (old-growth trees, stumps, logs and other signs of tree removal) to estimate forest conditions prior to livestock grazing, fire suppression and logging (1870 at Mount Trumbull, 1887 at Grandview). P. Z. Fulé (Northern Arizona University) provided the raw data that we used to recreate frequency distributions of basal area, dominant diameter class and canopy closure (Fig. 1). These were the only available data on presettlement conditions in nearby ponderosa pine and pine-oak forests. Soil types in these two areas were derived from the same parent materials (basalt, calcerous sandstone and limestone) as those in our study area. Because the two sites had similar distributions for each variable measured, we used the mean of the two distributions as the reference condition.

EVALUATING EMPIRICAL SUPPORT FOR ALTERNATIVE MODELS

For each set of reference conditions, we built two models that related goshawk reproduction (number of fledglings fledged per year monitored) to the percentage similarity of a goshawk breeding area to that reference forest structure. One model related reproduction only to conditions in the Central Zone; the second model had an additional term for the influence of the Foraging Band (Table 2).

We used an information-theoretic approach adjusted for small sample size (Akaike's information criterion (AIC$_c$); Burnham & Anderson 2002) to evaluate empirical support for each of the eight models. Because this approach will always identify the model with the best support, even when no model is well supported, we report only models that met minimal thresholds of $\Delta AIC_c < 5{\cdot}0$ and adjusted $r^2 > 0{\cdot}10$. We compared empirical support among the eight models.

Results

The 13 goshawk breeding areas varied in their percentage similarity to reference forest structures (see Table S2 in Supplementary material). The Central Zones of breeding areas were on average 32% similar (range 21–56%) to the forest structure recommended by the goshawk guidelines. When only the diameter distribution recommended by the guidelines was considered, average percentage similarity

Table 3. Models relating goshawk reproduction to the percentage similarity of a breeding area to a reference forest structure, for 13 goshawk breeding areas monitored 1993–2002 on the Apache–Sitgreaves National Forest, Arizona. Only models with $\Delta AIC_c < 5$ and $r^2 > 0{\cdot}10$ are shown. Eight models were tested

Model[a]	Reference forest structure	ΔAIC_c	r^2	Standardized coefficient	
				CZ	FB
2	Goshawk guidelines	0·0	0·45	−0·67	NA
4	Diameter distribution of goshawk guidelines	1·3	0·39	−0·40	NA
1	Goshawk guidelines	4·3	0·45	−0·64	−0·04

[a]Model number from Table 2.

increased to 50% (range 32–82%). The Foraging Band of a breeding area was somewhat more similar to the goshawk guidelines, averaging 43% similarity (range 26–57%) for the full prescription and 71% (range 53–85%) for the diameter distribution only. Percentage similarity between breeding areas and preferred foraging habitat averaged 65% in both the Central Zone and Foraging Band. Goshawk breeding areas were about 30% similar to presettlement conditions, with no Central Zone or Foraging Band exceeding 38% similarity.

Three of the four models relating goshawk reproduction to the goshawk guidelines were supported by the data (Table 3), including two models that included only effect of forest structure in the Central Zone, and one model that included effects of both the Central Zone and the Foraging Band. Contrary to expectation, however, goshawk breeding areas that resembled most closely the forest structure prescribed by the goshawk guidelines tended to have lower goshawk productivity (Table 3, Fig. 2). This negative influence was most pronounced for forest conditions in the Central Zone, for which a 1 standard deviation (SD) increase in percentage similarity was associated with a half SD decrease in productivity. The similarity of the Foraging Band to the goshawk guidelines had a negative association with goshawk productivity in only one model, but the coefficient was close to zero (Table 3). In light of these surprising results, we examined models for the three worst years of goshawk reproduction (1997, 2001 and 2002), as well as the three best years of goshawk reproduction (1995, 1996 and 1998; details in Table S1 of Supplementary material). In both cases the same models were supported, and the sign and size of standardized coefficients were similar to those observed across all 9 years. No r^2 value exceeded 45% (Table 3).

No model relating goshawk reproduction to ideal foraging habitat or to presettlement forest structure was supported by the data. Because our linear models could be insensitive to non-linear trends we examined scatterplots, which confirmed the lack of association between fledgling success and these two forest structures in either the Central Zone or Foraging Band.

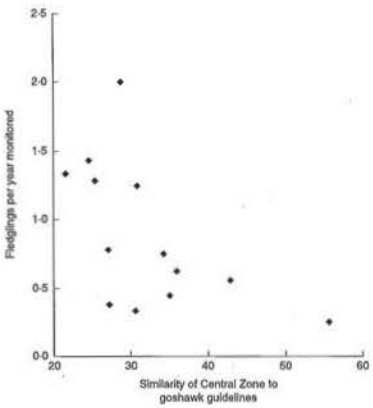

Fig. 2. Mean number of goshawk fledglings per year monitored decreased with increasing similarity to the goshawk guidelines for $n = 13$ territories monitored on the Apache–Sitgreaves National Forest, Arizona over 9 years ($r^2 = 0{\cdot}45$).

Discussion

A PRIORI HYPOTHESES

None of the expected associations between goshawk reproduction and forest structure were confirmed. There was no evidence of increased goshawk reproduction in breeding areas that resembled preferred foraging habitat, or of decreased reproduction in forest structure more similar to presettlement conditions.

The strongest pattern was that, contrary to our hypothesis, production of fledglings decreased as the breeding area's similarity to the goshawk guidelines increased. Why did goshawk reproduction not increase with similarity to the goshawk guidelines? One possibility is that Reynolds *et al.* (1992) estimated inaccurately forest conditions that maximize prey abundance. Their procedure involved three key decisions or interpretations, each of which was subject to uncertainty (Arizona Game and Fish Department 1993). First, Reynolds *et al.* (1992) gave each prey species equal weighting in their analysis, despite differences among prey species in biomass, abundance and contribution to goshawk diet, and despite the fact that six of the 14 species are unavailable in winter. Secondly, Reynolds *et al.* (1992) interpreted primary literature to estimate whether each species was found in low, moderate or high abundance in each VSS canopy closure class. These interpretations were necessarily subjective because the primary literature did not use VSS as an independent variable and because the three abundance classes were not defined explicitly. Thirdly, Reynolds *et al.* (1992) translated tallies of the number

of species scoring 'high' and 'medium' in each VSS class into optimal percentages of the landscape in each class. Although Reynolds *et al.* (1992) discussed and interpreted these tallies thoughtfully, others (e.g. Arizona Game and Fish Department 1993) interpreted these same data as supporting a prescription with larger fractions of the landscape dominated by larger trees and denser canopy closures. Errors at each step in the process could have synergistic effects that compromised this conceptual model.

Another possibility is that Reynolds *et al.* (1992) erred in their fundamental assumption that goshawks are habitat generalists and prey specialists that thrive best in a landscape with abundant prey. Drennan & Beier (2003) and Greenwald *et al.* (2005) questioned this assumption and emphasized evidence that goshawks are prey generalists and habitat specialists.

Finally, the goshawk guidelines use a forest descriptor (VSS) that has never been evaluated rigorously for its utility as a descriptor of wildlife habitat (although it was developed originally for this purpose: Thomas 1979). To the extent that VSS is an inappropriate descriptor it would contribute to statistical noise in our analyses, but such noise is unlikely to cause the negative correlation we observed.

Our results offer no support for the alternative hypothesis that reproductive success increases in breeding areas with increasing percentage of ideal foraging habitat. Empirical studies of foraging locations selected by goshawks in the western United States (summarized by Greenwald *et al.* 2005) were remarkably consistent in documenting that goshawks use forest structures characterized by relatively dense canopy and many large trees, but do not use sites with higher prey abundance. Goshawks in France also seem indifferent to prey abundance but partial to large trees and high crown volumes (Penteriani, Faivre & Frochot 2001). Because these forest conditions did not improve goshawk reproduction, we speculate that perhaps these forest conditions are associated positively with demographic parameters that we did not measure, such as reproductive life span, or adult or post-fledging survival.

Presettlement forest structure (< 250 stems ha^{-1}, < 40% canopy closure, < 1 large snag and < 1 large log per ha; Fulé *et al.* 2002; Waltz *et al.* 2003) differs markedly both from preferred habitat and from the recommendations of the goshawk guidelines. Thus we expected that similarity to this structure would be correlated negatively with goshawk reproduction. Our results do not support this notion. However, no goshawk breeding area was > 39% similar to restored conditions, and we caution against extrapolating our results to the effects of large-area restoration treatments.

The three forest structures we examined had only moderate influence on goshawk productivity. Two other studies, using different forest traits, found little influence of forest structure on reproductive success of northern goshawks in the western United States. Joy (2002) found that proportions of six vegetation types did not differ between 56 higher-productivity and 44 lower-productivity goshawk territories in a 9-year study in northern Arizona. Patla (1997) observed no effect of percentage mature forest on goshawk occupancy or goshawk productivity per occupied nest, and attributed this result to the fact that all territories had high (> 60%) percentage mature forest with little inter-territory variation. The most regularly occupied territories in her study were characterized by relatively greater proportions of mature forest cover. Patla (1997) also observed a small positive effect of sage-scrub openings on occupancy and reproduction ($r^2 = 0{\cdot}22$) and speculated that prey production was relatively high in those openings.

The low correlations we observed may be related to the fact that our circular areas did not necessarily correspond to areas of most intense goshawk use. None the less, we believe the 1215-ha circular areas we sampled included most areas used by breeding goshawks parents and fledglings during the breeding season. On the nearby Coconino National forest, mean home range size (95% harmonic mean) during the breeding season was 840 ha for 23 females and 1341 ha for 12 males (Hall 2001). Similarly, our 880-m radius Central Zone probably includes areas most important to juveniles and adult females during the fledgling dependency period. Kennedy *et al.* (1994) reported that 96% of the locations of fledglings were within 800 m of the nest during the first 4 weeks of the juvenile dependency period, decreasing to 76% in the last 4 weeks. However, these home range areas are not circular, and goshawks use areas within their home range non-uniformly (Kennedy *et al.* 1994; Beier & Drennan 1997).

WHAT MAKES SOME GOSHAWK BREEDING AREAS MORE PRODUCTIVE THAN OTHERS?

Like Krüger & Lindström (2001), we observed that some goshawk breeding areas consistently produced more fledglings than others. The contrary findings of McClaren *et al.* (2002) may reflect their use of fledglings per active nest as the response variable, ignoring differences in occupancy rates among breeding areas. However, if forest structure does not drive productivity, what does? Plausible hypotheses include prey abundance, disturbance, weather patterns and parenting ability of goshawk breeders.

Prey abundance was correlated with year-to-year variation in reproduction for goshawk populations studied for 4–10 years in the western United States (Doyle & Smith 1994; Keane 1999; Salafsky, Reynolds & Noon 2005) and Sweden (Tornberg, Korpimäki & Byholm 2006), but was uncorrelated with goshawk population growth in a 24-year time-series in Germany (Krüger & Lindström 2001). Based on the three US studies, we believe that prey abundance is a major driver of year-to-year variation in reproduction for goshawk populations in the western United States. A reasonable hypothesis is that prey abundance also drives reproductive variation among goshawk breeding areas. To our knowledge, no study has tested this hypothesis.

Disturbance levels, such as number of roads, traffic volume on roads or trails, amount of residential development, timber harvest and research activity (e.g. nest checks, nest surveys) could also affect goshawk reproduction. These disturbances were relatively constant across our 13 breeding areas, but we believe that an unauthorized camping area did cause abandonment of one breeding area that had been consistently

productive before intensive camping began near the nest stand.

Weather patterns, such as spring and summer precipitation, are correlated with between-year variation in goshawk reproduction (Kostrzewa & Kostrzewa 1990; Patla 1997; Penteriani 1997; Ingraldi 1999; Bloxton 2002; Fairhurst & Bechard 2005). However, for such effects to account for variation among goshawk breeding areas, the breeding areas would have to experience different weather patterns. We do not believe this was the case on our study area.

Finally, our most productive breeding areas may have reflected qualities of the breeding pairs rather than forest structure within the breeding area. However, given a mean reproductive life span of 2 years (Wiens & Reynolds 2005), several generations of high-quality parents would have to use a given breeding area to create high productivity over 9 years of observations. Until a researcher devises a method to measure parenting ability independently from nest success, it would be difficult to design a study to test this hypothesis rigorously.

MANAGEMENT IMPLICATIONS

The goshawk guidelines were conceived as an approach to management that would address the needs of multiple species (goshawks and 14 prey species) and meet other forest objectives (Reynolds *et al.* 1992). Compared to the years when production of fibre and ungulates drove forest management, the guidelines marked a big step towards ecosystem management and conservation of all native species. However, the assumptions behind the guidelines remain a set of largely untested hypotheses. Despite small sample size and the use of an observational rather than experimental approach, we found a moderate negative correlation between goshawk productivity and the forest structure prescribed by the guidelines. This calls into question the purported benefit to goshawks. Studies have not yet addressed response of the 14 prey species.

These results raise questions about the decision (US Forest Service 1996) to implement the goshawk guidelines on most Forest Service lands in Arizona and New Mexico. In (1993, the Arizona Game and Fish Department (1993: 62) recommended that the Forest Service 'identify areas... which reflect the desired future conditions identified in the [goshawk guidelines, and] ... monitor these areas to see if goshawks and the 14 targeted prey have responded as expected'. Our study suggests that goshawks did not respond as expected, and the monitoring and adaptive management approach recommended in 1993 is equally important today.

More broadly, many prescriptions for managing forests and other wildlands are based on ecological hypotheses. Managers should evaluate empirical support for the ecological hypotheses that are being applied to large landscapes. Careful allocation of areas to prescription and control sites, adequate replication and long-term monitoring are essential to evaluate empirical support in the most rigorous fashion. Observational studies such as ours can be a fast and relatively inexpensive alternative.

Acknowledgements

Funding was provided by the Bureau of Land Management through the Ecological Restoration Institute, Northern Arizona University, and Pittman-Robertson Federal Aid in Wildlife Restoration Project W-78-R and Heritage Programs of the Arizona Game and Fish Department. Among many helpful personnel at Apache–Sitgreaves National Forest, S. deRaaleve and H. Ray provided logistic support during the demography surveys and D. Beal helped us to access the Forest Service inventory protocols and algorithms. Arizona Game and Fish Department provided housing for field crews. P. Z. Fulé provided new data used to define tree size distributions under presettlement conditions. Field crews for the vegetation surveys included B. Blabach, D. Grossblatt, A. Horton, S. Lantz, A. Rogers, A. Ross, K. Rupert, K. Sostaert and R. Wilcox. M. Bechard, J. Bednarz and M. Morrison provided helpful comments on earlier drafts of this paper.

References

Arizona Game and Fish Department (1993) Review of US Forest Service strategy for managing northern goshawk habitat in the southwestern United States. Unpublished report. Arizona Game and Fish Department, Phoenix, AZ.

Arizona Game and Fish Department (undated) Wildlife of Special Concern in Arizona. Arizona Game and Fish Department, Phoenix, AZ.

Beier, P. & Drennan, J.E. (1997) Forest structure and prey abundance in foraging areas of northern goshawks. *Ecological Applications*, **7**, 564–571.

Bloxton, T.D. (2002) *Prey abundance, space use, demography, and foraging habitat of northern goshawks in western Washington*. Masters thesis, University of Washington.

Boal, C.W. (1994) A photographic and behavioral guide to aging nestling northern goshawks. *Studies in Avian Biology*, **16**, 97–102.

Bray, J.R. & Curtis, J.T. (1957) An ordination of the upland forest communities of southern Wisconsin. *Ecological Monographs*, **27**, 325–349.

Burnham, K.P. & Anderson, D.R. (2002) *Model Selection and Multimodel Inference: a Practical Information-Theoretic Approach*, 2nd edn. Springer, New York.

Covington, W.W. & Moore, M.M. (1994) Southwestern ponderosa forest structure: changes since Euro-American settlement. *Journal of Forestry*, **92**, 39–47.

Crocker-Bedford, D.C. (1990) Goshawk reproduction and forest management. *Wildlife Society Bulletin*, **18**, 262–269.

Crocker-Bedford, D.C. (1995) Northern goshawk reproduction and forest management. *Journal of Raptor Research*, **29**, 42–43.

Doyle, F.I. & Smith, J.N.M. (1994) Population responses of northern goshawks to the 10-year cycle in numbers of snowshoe hares. *Studies in Avian Biology*, **16**, 122–129.

Drennan, J.E. & Beier, P. (2003) Forest structure and prey abundance in winter habitat of northern goshawks. *Journal of Wildlife Management*, **67**, 177–185.

Eyre, F.H. (1981) *Forest Cover Types of the United States and Canada*. Society of American Foresters, Bethesda, MD.

Fairhurst, G.D. & Bechard, M.J. (2005) Relationships between winter and spring weather and northern goshawk (*Accipiter gentilis*) reproduction in northern Nevada. *Journal of Raptor Research*, **39**, 229–236.

Finn, S.P., Marzluff, J.M. & Varland, D.E. (2002) Effects of landscape and local habitat attributes on northern goshawk site occupancy in western Washington. *Forest Science*, **48**, 427–436.

Fritts, H.C. & Swetnam, T.W. (1989) Dendroecology: a tool for evaluating variations in past and present forest environments. *Advances in Ecological Research*, **19**, 111–188.

Fulé, P.Z., Covington, W.W. & Moore, M.M. (1997) Determining reference conditions for ecosystem management of southwestern ponderosa pine forests. *Ecological Applications*, **7**, 895–908.

Fulé, P.Z., Covington, W.W., Smith, H.B., Springer, J.D., Heinlein, T.A., Huisinga, K.D. & Moore, M.M. (2002) Testing ecological restoration alternatives: Grand Canyon, Arizona. *Forest Ecology and Management*, **170**, 19–41.

Greenwald, D.N., Crocker-Bedford, D.C., Broberg, L., Suckling, K.F. & Tibbitts, T. (2005) A review of northern goshawk habitat selection in the home range and implications for forest management in the western United States. *Wildlife Society Bulletin*, **33**, 120–129.

Hall, P.A. (2001) *Size and composition of northern goshawk (Accipiter gentilis) home ranges in north-central Arizona*. PhD thesis, Northern Arizona University.

Ingraldi, M.F. (1999) *Population biology of northern goshawks (Accipiter gentilis) in east-central Arizona*. PhD thesis, Northern Arizona University.

Joy, S.M. (2002) *Northern goshawk habitat on the Kaibab National Forest, Arizona: factors affecting nest locations and territory quality*. PhD thesis, Colorado State University.

Joy, S.M., Reynolds, R.T. & Leslie, D.G. (1994) Northern goshawk broadcast surveys: hawk response variables and survey cost. *Studies in Avian Biology*, **16**, 3–11.

Keane, J.J. (1997) *Ecology of the northern goshawk in the Sierra Nevada, California*. PhD thesis, University of California Davis.

Kennedy, P.L. (1997) The northern goshawk (*Accipiter gentilis atricapillus*): is there evidence of a population decline? *Journal of Raptor Research*, **31**, 95–106.

Kennedy, P.L., & Stahlecker, D.W. (1993) Responsiveness of nesting northern goshawks to taped broadcasts of 3 conspecific calls. *Journal of Wildlife Management*, **57**, 249–257.

Kennedy, P.L., Ward, J.M., Rinker, G.A. & Gessaman, J.A. (1994) Post-fledging areas in northern goshawk home ranges. *Studies in Avian Biology*, **16**, 57–62.

Kostrzewa, A. & Kostrzewa, R. (1990) The relationship of spring and summer weather with density and breeding performance of the buzzard (*Buteo buteo*), goshawk (*Accipiter gentilis*) and kestrel (*Falco tinnunculus*). *Ibis*, **132**, 550–559.

Krüger, O. & Lindström, J. (2001) Habitat heterogeneity affects population growth in goshawk *Accipiter gentilis*. *Journal of Animal Ecology*, **70**, 173–181.

Lang, J.N. (1985) A practical approach to density management. *Forest Chronicle*, **61**, 23–37.

Ludwig, J.A. & Reynolds, J.F. (1989) *Statistical Ecology*. Wiley and Sons, New York.

Moir, J.N., Fulé, P.Z., Moore, M.M., Covington, W.W. & Waltz, A.E.M. (1999) Restoration of pre-settlement age structure of an Arizona ponderosa pine forest. *Ecological Applications*, **9**, 228–239.

McClaren, E.L., Kennedy, P.L. & Dewey, S.R. (2002) Do some northern goshawk nest areas consistently fledge more young than others? *Condor*, **104**, 343–352.

McTague, J.P. & Patton, D.R. (1989) Stand density index and its application in describing wildlife habitat. *Wildlife Society Bulletin*, **17**, 58–62.

Patla, S.M. (1997) *Nesting ecology and habitat of the northern goshawk in undisturbed and timber harvest areas on the Targhee National Forest, Greater Yellowstone Ecosystem*. Masters thesis, Idaho State University.

Penteriani, V. (1997) Long-term study of a goshawk breeding population on a Mediterranean mountain (Abruzzi Apennines, central Italy): density, breeding performance, and diet. *Journal of Raptor Research*, **31**, 308–312.

Penteriani, V., Faivre, B. & Frochot, B. (2001) An approach to identify factors and levels of nesting habitat selection: across-scale analysis of goshawk preferences. *Ornis Fennica*, **78**, 159–167.

Reynolds, R.T., Graham, R.T., Reiser, M.H., Bassett, R.L., Kennedy, P.L., Boyce, D.A., Goodwin, G., Smith, R. & Fisher, E.L. (1992) *Management Recommendations for the Northern Goshawk in the Southwestern United States*. General Technical Report RM-217. US Forest Service Southwest Region, Albuquerque, New Mexico.

Salafsky, S.R., Reynolds, R.T. & Noon, B.R. (2005) Patterns of temporal variation in goshawk reproduction and prey resources. *Journal of Raptor Research*, **39**, 238–246.

Steenhof, K. (1987) Assessing raptor reproductive success and productivity. *Raptor Management Techniques Manual* (eds B.A. Pendleton, B.A. Millsap, K.W. Kline & D.M. Bird), pp. 157–170. National Wildlife Federation, Washington, DC.

Thomas, J.W. (1979) *Wildlife Habitats in Managed Forests: the Blue Mountains of Oregon and Washington*. US Forest Service Agricultural Handbook 553. US Government Printing Office, Washington, DC.

Tornberg, R., Korpimäki, E. & Byholm, P. (2006) Ecology of the northern goshawk in Fennoscandia. *Studies in Avian Biology*, **31**, 141–157.

US Fish and Wildlife Service (1995) *Recovery Plan for the Mexican Spotted Owl*. US Fish & Wildlife Service, Albuquerque, New Mexico.

US Fish and Wildlife Service (1998) *Northern Goshawk Status Review*. Office of Technical Support, Portland.

US Forest Service (1995a) *Forest Service Manual 2670*. Interim Directive no. R-3, 2670-2693-1. US Forest Service, Albuquerque.

US Forest Service (1995b) *Standard Specifications for Stand Exam, Rocky Mountain Region, Southwest Region, Intermountain Region*. Government Printing Office, Albuquerque, New Mexico.

US Forest Service (1995) *Final Environmental Impact*. Statement for Amendment of Forest Plans. US Forest Service Southwestern Region, Albuquerque.

US Forest Service (1996) *Record of Decision for Amendment of Forest Plans*. Southwestern Region, Albuquerque.

Waltz, A.E.M., Fulé, P.Z., Covington, W.W. & Moore, M.M. (2003) Diversity in ponderosa pine forest structure following ecological restoration treatments. *Forest Science*, **49**, 885–900.

Ward, L.Z., Ward, D.K. & Tibbitts, T.J. (1992) *Canopy Density at Goshawk Nesting Territories on the North Kaibab Ranger District, Kaibab National Forest*. Arizona Game and Fish Department Non-game and Endangered Wildlife Program, Phoenix, Arizona.

Wiens, J.D. & Reynolds, R.T. (2005) Is fledging success a reliable index of fitness in northern goshawks? *Journal of Raptor Research*, **39**, 210–221.

Woodbridge, B. & Detrich, P.J. (1994) Territory occupancy and habitat patch size of northern goshawks in the southern Cascades of California. *Studies in Avian Biology*, **16**, 83–87.

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Supplementary material

The following supplementary material is available for this article.

Table S1. Reproductive history of the 13 goshawk breeding areas 1993–2002.

Table S2. Percentage similarity to reference conditions and productivity for the 13 goshawk breeding areas.

This material is available as part of the online article from: http://www.blackwell-synergy.com/doi/full/10.1111/j.1365-2664.2007.01409.x
(This link will take you to the article abstract.)

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(18)

From: Andi Rogers
To: comments-southwestern-kaibab-williamsltfrb-fs@us; mutz@fs.fed.us; John J DeLuca
Cc: Sarah Reif; Larry Phoenix; Laura Clarkce; William_Austin@fws.gov; Barbara Cook
Subject: Bill Williams Restoration Project
Date: 05/23/2011 04:13 PM
Attachments: Bill Williams Restoration_AGFD Scoping_May 2011.pdf

Tom,

Attached are the Departments comments on the Bill Williams Project. Looking forward to our meeting and working with you all on the project.

ANDI ROGERS, HABITAT SPECIALIST, REGION II
Arizona Game and Fish Department
3500 S. Lake Mary Road
Flagstaff, AZ 86001
Phone (928) 214-1251
Fax (928) 779-1825

THE STATE OF ARIZONA
GAME AND FISH DEPARTMENT
5000 W. CAREFREE HIGHWAY
PHOENIX, AZ 85086-5000
(602) 942-3000 • WWW.AZGFD.GOV
REGION II, 3500 S. LAKE MARY ROAD, FLAGSTAFF, AZ 86001

May 23, 2011

Tom Mutz , Team Leader
742 S. Clover Road
Williams, AZ 86046

RE: Bill Williams Restoration Project

Dear Mr. Mutz,

The Arizona Game and Fish Department (Department) has reviewed the scoping packet for the Bill Williams Mountain Restoration project dated April 2011. We would like to thank the Kaibab National Forest (Forest) for the opportunity to comment early in the development of this project. As you are aware, Bill Williams Mountain supports a diverse array of wildlife and habitats across a wide elevational gradient. We recognize that this project is in an early planning phase, and would appreciate extensive coordination on this project as it proceeds.

Below are the Department's key comments on the scoping packet:

General:

18-1 • The Department requests clarification over whether the Forest is proposing a fuels reduction project or an ecological restoration project? We believe that this upfront clarification will garner more effective communication between the Forest and interested stakeholders. If reduction in fuels is the main objective, a more strategic design and placement of evidence-based restoration treatments could more effectively protect values at risk, thereby reducing the need to aggressively treat the entire project area. We believe this approach will also help the fire-adapted, ecological function of the landscape.

• The Department recommends numerous field trips in the spring and summer to discuss objectives of the project.

18-2 • The Department questions whether methods such as cable logging can be done in an ecologically sound manner on Bill Williams Mountain. The Department does not support the harvest of old growth trees, therefore, if it is deemed necessary to thin steep slopes on the mountain for cable logging, we would recommend alternative ways to achieve this goal that can be more selective in harvest, and result in a more "natural" resulting structure.

18-3 • The Department would like to have further discussions about the fuels control lines being proposed by the Forest. As proposed, the resulting linear structure from these treatments may meet fuels objectives, but likely will not meet restoration objectives. Again, we encourage the Forest to convey to the public if this is a fuels reduction project or an ecological restoration project.

18-4 • We ask that the Forest to include a thorough description for old growth throughout the planning of this project. While tree age is an essential aspect, old growth should describe more features of a late-successional forest than just the standing live trees. As you are aware, there are essential structural features of old growth as old trees, snags and large dead/downed fuels, and between-patch structural variability (with large trees and age variability as additional features for consideration, depending on forest type). We recommend the Forest expand its definition to include the essential structural features of old growth for the purposes of the Bill Williams planning document.

18-5 • Because Gambel oak and aspen are relatively rare habitat types, we ask the Forest to be careful and strategic in the treatments of these vegetation types.

18-6 • Structural heterogeneity is very important to wildlife, both in terms of horizontal and vertical structure. We ask that the Forest recognize that although ladder fuels can cause increased fire risk, they are important to wildlife, and should not be eliminated across large areas of the landscape.

• The Department supports meadow, grassland, and open savannah treatments as they pertain to the Bill Williams project.

Ponderosa Pine:

• The Department is an advocate for forest restoration and reducing unsustainable densities in the ponderosa pine vegetation type. However, we also recognize the importance of the historic range of variability, which in addition to open, park-like conditions also includes forest conditions that favor closed canopy species.

18-7 • We encourage the Forest to manage toward habitat diversity that includes greater variability in forest/meadow patch size, vertical heterogeneity (multi-layered canopies), tree density, basal area, and successional stage with an emphasis on old growth retention.

18-8 • Specific to the Scoping Packet, we ask the Forest to strongly consider a wider Basal Area (BA) within the Desired Conditions, as 10-50 BA will not support many of our closed canopy species.

18-9 • We ask that you place more emphasis on ensuring a mosaic of all successional stages, now and in the future, throughout a landscape comprised of all known habitat types.

• In order to facilitate this approach, please refer to and draw from our attached AGFD-USFWS DRAFT document "*Desired Ponderosa Pine Forest Conditions for Wildlife in the Southwest*". This is still a draft document, and be advised that we have initiated a revision of this document in collaboration with Ecological Restoration Institute. We will keep you posted on our progress toward a final document.

Mixed Conifer

• The Department would like to work closely with the Forest on appropriate treatments for mixed conifer.

18-10 • Unlike ponderosa pine, there is relatively little existing information on the historic reference condition of mixed conifer. In addition, within the Kaibab Health Focus Group final report it was recognized that there is lack of consensus on how to treat mixed conifer (see page 23). Staying true to the recommendations from that document, the Department would advocate that the Forest take an smaller scale experimental approach to treatment in mixed conifer.

• The Department would like to know if the Forest plans on treating the mixed conifer vegetation within the two categories of wet and dry mixed conifer, as has been done in Forest planning? As with historic reference condition, there is little information on the fire interval of dry mixed

conifer. To this end, we are somewhat concerned about the similarity we see between PIPO DFCs and mixed conifer-frequent fire DFCs and wonder how that may or may not play out on

18-11 Bill Williams. With such similar management direction for the two vegetation types our concern is that we will convert dry mixed con – frequent fire into PIPO when actually it's an important and distinct Potential Natural Vegetation Type.

18-12 • Also related to dry mixed conifer, how will this vegetation type be defined, and subsequently mapped?

18-13 • If the Forest is going to continue with the dry mixed conifer concept, we recommend addressing the importance of retaining transitional, ecotonal habitats between ponderosa pine and mixed conifer for wildlife.

The Department is committed to assisting the Forest in designing a project that reduces fuel in such a manner as to restore the spatial heterogeneity and ecological function to the landscape, while simultaneously protecting the city of Williams from non-natural fire. Thanks for your time and please feel free to contact me with any questions you may have.

Sincerely,

Andi Rogers
Habitat Specialist, Flagstaff
(928) 214-1251
arogers@azgfd.gov

cc:

Sarah Reif, Habitat Program Manager
Laura Canaca, Project Evaluation Program Manager
Bill Austin, USFWS Ecological Services
Larry Phoenix, Field Supervisor

(19)

From: Sandy Bahr
To: comments-southwestern-kaibab-williams@fs.fed.us
Subject: Bill Williams Restoration Project
Date: 05/27/2011 11:39 AM
Attachments: 2011_5_27 BWM Restrtn Scoping Sierra Club.pdf

Please see attached. Thank you.

Sandy Bahr
Chapter Director
Sierra Club - Grand Canyon Chapter
202 E. McDowell Rd, Suite 277
Phoenix, AZ 85004
Phone (602) 253-8633
Fax (602) 258-6533
sandy.bahr@sierraclub.org
arizona.sierraclub.org

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Grand Canyon Chapter • 202 E. McDowell Rd, Ste 277 • Phoenix, AZ 85004
Phone: (602) 253-8633 Fax: (602) 258-6533 Email: grand.canyon.chapter@sierraclub.org

May 27, 2011

Tom Mutz, Team Leader, Kaibab
National Forest, Williams Ranger
District, 742 S. Clover Road
Williams, AZ 86046

Submitted via email comments-southwestern-kaibab-williams@fs.fed.us

Subject: Bill Williams Mountain Restoration Project

Dear Mr. Mutz:

Thank you for the opportunity to comment on the Bill Williams Mountain Restoration Project. Please accept these comments on behalf of the Sierra Club's Grand Canyon (Arizona) Chapter and our more than 12,000 members in Arizona.

The Sierra Club's mission is "to explore, enjoy, and protect the wild places of the earth; to practice and promote the responsible use of the earth's ecosystems and resources; and to educate and enlist humanity to protect and restore the quality of the natural and human environments." The Grand Canyon Chapter has long been committed to protection of Arizona's lands, wildlife, water, and communities. Our members are concerned about the lands included in this proposal and have enjoyed recreational activities in the area including hiking and wildlife viewing.

The Sierra Club recognizes the need to protect Bill Williams Mountain from catastrophic wildfire, and to improve the watershed conditions. We would like to offer some suggestions to be considered in the draft Environmental Impact Statement to ensure that this project is consistent with the stated purpose "to improve the health and sustainability of the forested conditions on and surrounding Bill Williams Mountain" and to "improve the watershed conditions contributing to the City of Williams water supply."

Purpose and Need for Action:

The Sierra Club supports an amendment to the Kaibab National Forest (KNF) Land Management Plan that would allow restoration treatments to move vegetative conditions toward reference conditions, precluding timber production. We commend the Kaibab National Forest for seeking to add this language to the Forest Plan, and for managing forests for sustainable ecosystems.

19-1 The Sierra Club agrees that it is appropriate to provide firewood derived from this project to people living in Williams, Arizona and the surrounding area. While the Sierra Club supports making wood derived from thinning treatments available to residents for personal use, we do not support large scale commercial extraction of timber from our National Forests. Please consider altering the Specific Need statement from "To provide forest products, such as firewood, for people living in Williams and the surrounding area, in order to

meet their needs for forest and wood products, while protecting these resources for future generations" to "…in order to meet their *personal use* needs…"

Please add to the "need for" list:

- Preventing erosion and soil loss that could further impair watersheds.
- Protecting rare, threatened, and endangered species.
- Protecting and enhancing wildlife habitat.

Emphasize Restoring Forest Resiliency

Department of Agriculture Secretary Vilsack recently stated, "Our shared vision begins with restoration. Restoration means managing forest lands first and foremost to protect our water resources, while making our forests more resilient to climate change" (Forest Service 2009). The Forest Service Manual FSM 2020 defines Ecological Restoration as "the process of assisting the recovery of resilience and adaptive capacity of ecosystems that have been degraded, damaged, or destroyed. Restoration focuses on establishing the composition, structure, pattern, and ecological processes necessary to make terrestrial and aquatic ecosystems sustainable, resilient, and healthy under current and future conditions."

Mature, natural forests are resilient to disturbances because of their genetic, taxonomic and functional biodiversity. This resilience includes regeneration after fire, resistance to and recovery from pests and diseases and adaptation to changes in radiation, temperature and water availability including those resulting from global climate change (Mackey et al. 2008:5).

19-2 We encourage the Forest Service to focus this project on restoration of natural processes, such as fire, and restoring forest resiliency to help address the impacts of climate change and the historic impacts of fire suppression, logging, and livestock grazing.

Proposed Action

The Scoping Packet identifies mechanical thinning treatments that could occur on the entire project area. At the public meeting in Williams on May 11, 2011, it was acknowledged that the project would take several years to complete, and some areas could be prohibitively expensive. On page 6, it says under the "Prescribed Fire" heading, "In areas where operability is limited and more costly (Zones 3, 4, 5, & 7), only prescribed burning may be used to meet resource objectives; this would be dependent on implementation of the strategic
19-3 fuel treatments designed to enhance control lines." The Sierra Club supports the use of fire to restore ecosystems, and finds this alternative preferable to mechanical treatments on steep slopes where mechanical treatment could lead to erosional problems and dangerous conditions. Helicopter treatments on 3,468 acres is not defensible and is an unnecessary expense for the KNF, a safety hazard, and a significant disturbance to wildlife and nearby residents.

19-4 The Arizona Bugbane botanical area boundary should be respected. Treatments should protect the boundary, but mechanical treatment should not occur within the area because machines move across the ground too quickly for operators to observe details of vegetation composition. Skid trails in this area could also invite non-native invasive species.

19-5 The Strategic Fuels treatments should be considered in the context of restoring natural fire to the forest. Rather than creating artificial linear swaths, the Forest Service should focus on utilizing the natural features of the land, including the vegetative features for fuel breaks. This means using the using the existing heterogeneity and creating additional vertical breaks where necessary. This should be minimized in order to reintroduce natural fires. (Allen et al. 2002, Weatherspoon and Skinner 1996). The wide, relatively straight clearings running perpendicular to slopes proposed can cause soil loss and habitat fragmentation and if the goal is to continue fire exclusion, then the treatments will be counterproductive.

19-6 The Forest Service should consider implementing fuel reduction first in areas where limited resource investment may be able to create more fire resilient stand conditions. This may include sites with little encroachment of small trees and open stands dominated by large conifers or hardwoods. Targeting initial work in these areas will maximize the area to be treated with available funds and personnel, and thereby provide the
19-7 greatest opportunity to quickly reduce fuels and restore ecosystem function at larger spatial scales. Larger, fire resistant trees should be left uncut.

Alternatives

The National Environmental Policy Act (NEPA) requires that the Forest Service consider and "[r]igorously explore and objectively evaluate all reasonable alternatives." *40 C.F.R.* § 1502.14(a); 42 U.S.C. § 4332(2)(E) This helps provide for clearer definition of relevant issues for environmental analysis and provides a basis for choice among options.

19-8 We agree with comments submitted by the Center for Biological Diversity and ask that the Forest Service develop and evaluate an alternative that would meet the purpose and need for action while conserving any presettlement and large trees outside of a well-defined wildland-urban interface - approximately ¼ mile from established community infrastructure.

Current Conditions

Table 2 gives conditions for riparian/wetland vegetation. At the public meeting in Williams on May 11,
19-9 2011, KNF representatives said that there was no riparian vegetation in the treatment area. If there is riparian vegetation, wetland emergent vegetation, wetland or aquatic habitats in the treatment area, thinning activities should leave a buffer zone around these places that is sufficient to anchor soils and capture ash that may flow downhill after prescribed or naturally-occurring fires. This will protect water quality. Mechanical equipment should not be allowed to pass through these fragile, important habitats.

Removal of white fir ladder fuels is a major goal of this project. White fir is a natural component of Bill Williams Mountain forests, and does have habitat value. Prone to heart rot and wind throw, white fir house
19-10 cavity nesters and insectivorous birds (Hopkins 1982, Airola and Barrett 1985). White fir germinates well in bare mineral soils, so burning will contribute to a new generation of white fir saplings. Frequent fire will be required to regularly re-treat and suppress white fir.

19-11 Seeding the understory after treatments may help to inhibit non-native invasive species, and to shade
19-12 white pine seeds, to prevent germination. Keeping livestock grazing out of areas where white pine is undesirable might also be helpful, since a dense, healthy understory will suppress woody species germination.

Since white pine understory below ponderosa "is most apparent in these stands closer to the base of Bill Williams Mountain" (p. 14), the goal of reducing the ladder fuels below ponderosa should be achievable without having to perform mechanical treatments in the "limited and more costly" zones. This area is also most 19-13 important for treatment to protect the wildland-urban interface. For these reasons, mechanical treatment near the base of the mountain only, and treatment exclusively with fire higher up on the mountain, is desirable.

19-14 The plan states that regeneration of younger trees is inhibited by fairly even-aged stands (p.16). Pre-settlement and any and all old growth trees should not be cut. **Large trees should not be cut to make room for regeneration.** Conservation of large trees in fuel treatments is critical to restoration of fire-adapted forest 19-15 ecosystems (Brown et al. 2004, DellaSala et al. 2004). Some shrubs should be left in the understory to provide 19-16 forage, cover, and nesting sites for wildlife. Some pockets of very high density forest should be left intact. After the forest is thinned and openings are created, some regeneration will naturally occur, unless the soil is 19-17 compacted from heavy equipment. Understory seeding with a native seed mix should follow treatment, to suppress non-native invasive species, many of which increase fire risk on the landscape.

19-18 Impacts of livestock grazing should be considered as well. Livestock grazing contributes to the long-term and degradation of grasslands contributes to the encroachment of noxious and invasive weeds as well as 19-19 woody vegetation. Spread of noxious weeds is a reasonably foreseeable and potentially significant forest-wide cumulative impact of the proposed action.

19-20 Insects, diseases, and mistletoe are naturally part of the system (p.17). Once needles fall from dead trees, active crown fire risk in those stands may be reduced (Fleming et al. 2002, Romme et al. 2006, Jenkins et al. 2007). It is unclear what treatments are being proposed to deal with insects, disease, and mistletoe. Since snags and witches' brooms provide important habitat values, and mistletoe provides a drought-resistant food source for wildlife, the best treatment of these areas may be to burn them but not mechanical treatment.

Mexican Spotted Owl

The Bill Williams Restoration project area overlaps with habitat for the threatened Mexican spotted owl. Activities associated with this project, including any logging, road construction and prescribed fire may affect 19-21 spotted owl critical habitat. Because of concerns about failure to monitor and inadequate monitoring and the potential for this project to result in an exceedance of incidental take relative to this species, we ask that the Forest Service refrain from actions that would affect the owls until they the Forest Service has consulted with the U.S. Fish and Wildlife Service to ensure that this project would not result in significant harm to the owls and their habitat and exceedance of incidental take.

19-22 The Sierra Club can*not* support a one-time deviation from Forest Plan guidelines for Mexican spotted owls at this time. Please be explicit about the activities the KNF is seeking to undertake in these areas, how they deviate from current guidelines, why they are necessary, and how much habitat would be affected by the amendment.

Northern Goshawk

As the Forest Service knows, the implementation of the *Management Recommendations for the Northern Goshawk (MRNG) in the Southwestern United States* (Reynolds et al. 1992) has been and continues to 19-23 be scientifically controversial as a means of ensuring population viability for the northern goshawk. The

Scoping Document is not specific about what deviations from these guidelines are needed, but the Sierra Club asks that the Forest Service consider the study by Beier and others (2008) that detected a negative correlation of goshawk breeding productivity with territories that were treated by logging consistent with the *MNRG* (Reynolds et al. 1992) and the amended forest plans and that populations of the northern goshawk are in decline across the forest. Please be explicit about the activities the KNF is seeking to undertake in these areas, how they deviate from current guidelines, why they are necessary, and how much habitat would be affected by the amendment.

Thank you for considering our comments. Please keep us informed about this project.

Sincerely,

Alicyn Gitlin
Sierra Club Grand Canyon Chapter
318 W. Birch Ave. #8
Flagstaff, AZ

Literature Cited

Airola, D. A., and R. H. Barrett. 1985. Foraging and habitat relationships of insect-gleaning birds in a Sierra Nevada mixed conifer forest. Condor 87:205-216.

Allen, C.D. M.A. Savage, D.A. Falk, K.F. Suckling, T.W. Swetnam, T. Schulke, P.B. Stacey, P. Morgan, M. Hoffman, and J.T. Klingle. 2002. Ecological restoration of southwestern ponderosa pine ecosystems: A broad perspective. *Ecological Applications* 12:1418-1433.

Beier, P., E.C. Rogan, M.F. Ingraldi and S.S. Rosenstock. 2008. Does forest structure affect reproduction of northern goshawks in ponderosa pine forests? *Journal of Applied Ecology* 45: 342-350. Brown, R.T., J.K. Agee, and J.F. Franklin. 2004. Forest restoration and fire: principles in the context of place. *Conservation Biology* 18:903-912.

Fleming, R.A., J. Candau, and R.S. McAlpine. 2002. Landscape-scale analysis of interactions between insect defoliation and forest fire in central Canada. Climatic Change 55:251-272.

Forest Service. 2009. Agriculture Secretary Vilsack Presents National Vision for America's Forests. News Release No. 0382.09, August 14, 2009. http://www.usda.gov/wps/portal/!ut/p/_s.7_0_A/7_0_1OB?contentidonly=true&contentid=2009/08/0383.xml

Hopkins, W. E. 1982. Ecology of white fir. Pages 35-41 In C.C. Oliver and R. M. Kenady, eds. Proceedings of the biology and management of true fir in the Pacific Northwest. Univ. of Washington, Col. of Natur. Res. (Seattle, Wash.), Cont. No. 45.

Jenkins, M.J., E. Hebertson, W. Page, and C.A. Jorgensen. 2007. Bark beetles, fuels, fires, and implications for forest management in the Intermountain West. Forest Ecology and Management. 254:16-34.

Mackey, Brendan G., Heather Keith, Sandra L. Berry, and David B. Lindenmayer. 2008. *Green Carbon: The Role of Natural Forests in Carbon Storage*. Canberra ACT 0200, Austrailia: Australian National E. Press. http://epress.anu.edu.au/green_carbon_citation.html

Reynolds, R.T., R.T. Graham, M.H. Reiser, R.L. Bassett, P.L. Kennedy, D.A. Boyce, G. Goodwin, R. Smith, and E.L. Fisher. 1992. *Management Recommendations for the Northern Goshawk in the Southwestern United States*. USDA For. Serv. Rocky Mtn. Res. Sta. Gen. Tech. Rep. RM-GTR-217. Fort Collins, CO.

Romme, W.H., C.J. Hicke, D. Kulakowski, L.H. MacDonald, T.L. Schoennagel, and T.T. Veblen. 2006. Recent forest insect outbreaks and fire risk in Colorado forests: a brief synthesis of relevant research. Colorado Forest Research Institute, 24 pp.

(20)

Arizona Department of Transportation
Flagstaff District – 1801 S. Milton Rd, Flagstaff, Az 86001

June 2, 2011

Tom Mutz, Team Leader
742 S. Clover Rd.
Williams, AZ 86046

Post-it® Fax Note 7671	Date 6-2-11	# of pages ▸ 3
To Tom Mutz	From Kurt Harris
Co./Dept.	Co. ADOT
Phone #	Phone # 928-779-7591
Fax # 928-635-8208	Fax #

Dear Tom Mutz,

Thank you for allowing us to comment on the Bill Williams Mountain Restoration Project (File Code: 1950, Date received: April 26th, 2011).

ADOT has been involved in the Four Agency Partnership (including USFS, BLM, ADOT and Federal Highway Administration) during the past numerous years. As a result of this partnership, there have been many cooperative and interagency agreements and understandings to meet the multiple agency objectives. Be sure to incorporate these agreements to all of your projects to continually contribute towards the Four Agency Partnership objectives. Please find the following comments and concerns in order to maintain, protect, and serve the traveling public, ADOT highway functions, and the Four Agency Partnership.

The following are ADOT's Flagstaff District's comments inclusively. ADOT would also like to improve continuity of communications with the National Forests within Arizona and provide productive feedback during the USNF Project Public Notice process. Other divisions of ADOT views or input are not included in this letter. Please include the following in your distribution list for future public notices, and, if other comments from ADOT are so desired, please contact:

Todd Williams, Director – Office of Environmental Services
1611 West Jackson St., Mail drop EM04
Phoenix, AZ 85007
Office phone: (602)-712-8272
Email: twilliams2@azdot.gov

20-1 ***ADOT's Flagstaff District supports the project to improve health and sustainability of adjacent forests to our highways. ADOT's greatest concern is the potential for impacts with the existing forest road (947?) that parallels our interstate right of way; with respect to potential higher year round use and any improvements (widening, increased drainage discharge to ADOT existing drainage structures, right of way fencing). The following are Flagstaff District contacts for your records that may need to be notified depending on potential impacts to Interstate 40 or our right of way from this project.***

The following is the contact for utility/drainage easement potential resultant impacts (temporary or permanent) from Bill Williams Mountain Restoration Project:

Arizona Department of Transportation
Flagstaff District – 1801 S. Milton Rd, Flagstaff, Az 86001

Dennis Johnson, ADOT Maintenance Supervisor
I40B MP 165.5 /P.O. Box 606
Williams, AZ 86046
Office phone: (928)-635-4301
Office fax: (928)-635-9314
Email: djohnson@azdot.gov

Please contact Dennis for coordination of any proposed work adjacent to ADOT's East Bound I-40 Right of Way (fencing); that may damage or improve fencing, increase stormwater discharges and potential debris, effects of snowplowing to fencing, control burning or fire treatment smoke that may reduce visibility on interstate or any unforeseen maintenance.

The following is the contact for coordination of potential traffic impacts resulting from the Bill Williams Mountain Restoration Project to East Bound I-40:

Kent Link, PE
1801 S. Milton Rd
Flagstaff, AZ 86001
Office phone: (928)-779-7570
Office fax: (928)-779-5905
Email: wlink@azdot.gov

The following is the contact for potential Encroachment Permits needed to enter or do activities within ADOT right of way from the Bill Williams Mountain Restoration Project:

Warren Sutphen
1801 S. Milton Rd
Flagstaff, AZ 86001
Office phone: (928)-779-7520
Office fax: (928)-779-5905
Email: wstuphen@azdot.gov

The following is the contact for coordination of vegetative management for invasive/noxious weeds or tree/brush removal within ADOT's Right of Way resulting from the Bill Williams Mountain Restoration Project:

Tom Eckler, Natural Resources Supervisor
5701 E. Railhead Ave,
Flagstaff, AZ 86004
ORG office phone: (928)-526-2582
Office fax: (928)-526-8617
Email: tecklerjr@azdot.gov

Arizona Department of Transportation
Flagstaff District – 1801 S. Milton Rd, Flagstaff, Az 86001

Wishing us success, sincerely,

Kurtis Harris, PE
Environmental Coordinator

for:

John Harper, PE
District Engineer

Appendix D – Past, Present and Reasonably Foreseeable Future Actions

Past, Present, and Reasonably Foreseeable Actions Considered in Specialist Reports

Kaibab National Forest, Williams Ranger District

Bill Williams Mountain Restoration Project

Following is a partial listing of actions considered in the cumulative effects analysis for this project:

- Activities such as vegetation management, fuels management, livestock grazing, recreational activities, and other management activities (e.g. noxious weeds treatments) have occurred in the past, are occurring, and are reasonably foreseeable actions on the District. These activities could occur on private lands as well.
- Firewood cutting has occurred in the past and would likely continue in the foreseeable future on the District and private lands.
- Private landowners may harvest timber on their lands for lumber or to reduce fire hazards.
- Urban development and interface growth will continue on private lands.
- Road construction, road maintenance and right-of-way brushing can be expected to continue on non-National Forest System land.
- Road maintenance, reconstruction, or decommissioning may occur with future vegetation management projects.
- Recreation activities are expected to continue to increase on the Forest. Future recreation projects may be developed.
- There is a multi-million dollar electronics site on the top of the mountain providing communications towers for the Department of Public Safety, USDA Forest Service, Arizona State Land Department, Burlington Northern Santa Fe railroad and several other governmental and private enterprises. Several special use permits exist and continue to be requested for the communications site such as cell tower extensions, new outbuildings, etc.
- The north side of the mountain is home to a small ski resort which operates periodically throughout the year with downhill skiing in the winter and tubing in the summer.

Following is a partial listing of projects considered in the cumulative effects analysis for this project:

Past:

Project	Year NEPA completed	Activities	Status
Spring Valley	1999	Timber Sales, Non-commercial thinning	Sales Complete
Pine-aire	2004	Timber sale (TS); Non-commercial thinning; Broadcast burning (BB)	Sales Complete; burning planned for 2012
Beacon	1997	Veg. Mgt: TS, Timber Stand Improvement (TSI), & Broadcast burning (BB);	Completed
Williams High Risk Project		Non-commercial thinning	Completed
Clover High Fuels Reduction Project		Non-commercial thinning	Completed

Present:

Project	Year NEPA completed	Activities	Status
City	2005	Veg. Mgt: TS, TSI, & BB; includes some temporary roads and dozer lines	Currently being implemented
Twin	2005	TSI & Fuel reduction; includes some temporary roads and dozer lines	Ongoing – Approx. 40% implemented
Bill Williams Cap	2009	Fuel reduction / Hazard Tree removal on 6 ac.	DN signed – implementation 2010
Williams Ranger District Travel Management Project	2010	Prohibit cross-country travel (except as designated on MVUM); close 380 miles of system roads to motor vehicle use.	Implemented in July 2011 with publication of MVUM
Hat Allotment Grazing Management	2010	Authorizes grazing	Ongoing
EIS for Treatment of Noxious or Invasive Weeds	2004	Treatment of Noxious or Invasive Weeds	Ongoing
Elk 2 (Elk/Lee)		Timber Sale	Small portion of sale remains to be cut
Lee 1 and 2 (Elk/Lee)		Timber Sale	Sale sold, not yet implemented
Wright Hill (SpringValley)		Timber Sale	Sale sold, not yet implemented

Horse Pine (Frenchy)		**Timber Sale**	**Sale in progress**
Moose (Frenchy)		**Timber Sale**	**Sale sold, not yet implemented**
Government 2 (Spring Valley)		**Timber Sale**	**Sale almost complete**
Dogtown (Dogtown)		**Timber Sale; Prescribed burning; Non-commercial thinning**	**Pending Sales; Ongoing burning**

Foreseeable Future:

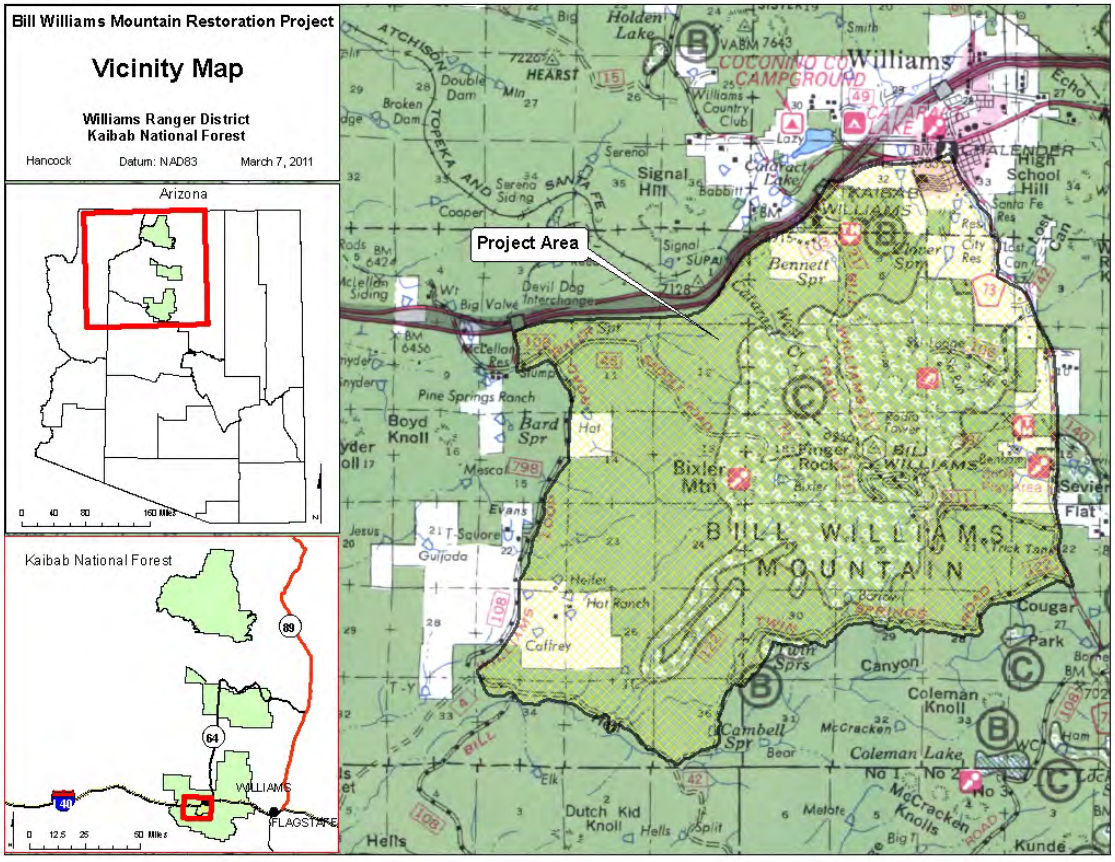
Project	**Estimated Year NEPA Completed**	**Activities**	**Status**
McCracken (WRD)	**2010**	**Thinning (15,200 ac), Burning (17,000 ac), Grassland Restoration**	**PA released in 2008; Decision expected in Fall 2011.**
Four Forest Restoration Initiative (Multiple Projects)	**Multiple**	**Restoration of Ponderosa Pine ecosystem (thinning, burning)**	**Planning team and collaborative group developing strategy and initial PA.**
KA, Isham, Pomeroy (Frenchy)		**Timber Sales**	**Pending sales**
Community Tank		**Timber Sale; Non-commercial thinning**	**Pending sale**

Appendix E – Existing and Desired Conditions Report

Existing and Desired Conditions Report for the Bill Williams Mountain Restoration Project

Area and Scope

The Bill Williams Mountain Restoration Project is located 4 miles south-southwest of the city of Williams, Arizona (see Vicinity Map). The project area is approximately 18,000 acres with about 2,500 of those acres being private land. It encompasses Bill Williams Mountain which is the primary watershed for the city, has historic and cultural value, and is an important communication site for Northern Arizona. The project area is bounded by I-40 on the north, Perkinsville Road on the east, FR 122 on the south and FR 108 on the west. All or portions of Sections 1-3, 10-15, 22-27, & 34-36 T21N R1E; Sections 4-10, 15-22, & 27-31 T21N R2E; and Sections 31-33 T22N R2E Gila & Salt River Meridian are included in the project area.



The project area is guided by management direction described in the Kaibab National Forest Land Management Plan (Forest Plan) (1988, as amended). The project area falls within Geographic Area 2 – Williams Forestland and encompasses Land Use Zones 6 and 21. Land Use

Zone – Special Area 6 is a botanical area for the protection of Arizona Bugbane, a candidate species for threatened status. Land Use Zone 21 is an existing developed recreation site, the Elk Ridge Ski Area.

Current Condition

Watershed Health

Citizens of Williams, Arizona depend on the Williams Municipal Watershed as a source of public drinking water and for other benefits that multiple-use management of this watershed provide. Approximately one third (5,932 acres) of the project area occurs in the Williams Municipal Watershed, which is approximately 26,061 acres in size.

The project area overlaps portions of six subwatersheds, including the two subwatersheds of Cataract Creek Headwaters and Dogtown Wash which make up the majority of the land base within the Williams Municipal Watershed. Table 1 below lists the six subwatersheds, the total watershed area, and the project area acreage within each watershed.

Table 1. Subwatershed (HUC12) names and acreages occurring within the Bill Williams Restoration Project Area.

HUC12 Number	Subwatershed Name	Total Acres	Project Area Acres
150100040502	Cataract Creek Headwaters	16,695	5,148
150602020202	Devil Dog Canyon	11,192	1,331
150100040501	Dogtown Wash	11,660	816
150602010302	Johnson Creek	30,207	2,719
150602020203	Meath Wash	26,851	1,639
150602020204	Upper Hell Canyon	27,152	6,007
	Total	123,757	**17,660**

As can be seen in Table 2 below, three of the watersheds in the project area are currently impaired and three are functioning at risk. All watersheds in the project area have soils that are either impaired or functioning at risk. Reasons for these soil conditions include inadequate vegetative cover due to excessive fuel loads that prevent establishment of herbaceous understory vegetation; recent high-severity wildfire that has removed soil vegetative cover; and encroachment of ponderosa pine, pinion, and juniper into historically open meadows and savannahs. All of the watersheds in the project area exhibit departures from historic fire regimes (i.e., departures from historical ranges of variability in vegetation, fuel composition, fire frequency, fire severity, and fire pattern). Treatments that would reduce the risk of high-severity stand replacing wildfires would improve the fire regime condition and therefore improve watershed health in each of the treated watersheds. Road density, location, and distribution also contribute to impaired or functioning at risk watershed conditions.

Table 2. Watershed conditions of the six subwatersheds within the Bill Williams Mountain project area.

	Aquatic Physical	Aquatic Biological	Overall Watershed Score

Subwatershed Name	Watershed Acres	Water Quality	Water Quantity	Aquatic Habitat	Aquatic Biota	Riparian/Wetland Vegetation	
Cataract Creek Headwaters	16,695	2.0	3.0	3.0	2.0	3.0	2.4 - Impaired
Devil Dog Canyon	11,192	1.0	3.0	1.0	2.0	1.0	1.8 – Functioning at risk
Dogtown Wash	11,660	2.0	3.0	1.0	2.0	1.0	2.0 – Functioning at risk
Johnson Creek	30,207	2.0	3.0	3.0	2.0	3.0	2.4 – Impaired
Meath Wash	26,851	1.0	3.0	1.0	2.0	1.0	1.7 – Functioning at risk
Upper Hell Canyon	27,152	1.5	2.0	3.0	2.0	3.0	2.4 - Impaired
Total	123,757						

	Terrestrial Physical		Terrestrial Biological				
Subwatershed Name	**Roads and Trails**	**Roads and Trails**	**Fire Regime**	**Forest Cover**	**Rangeland Vegetation**	**Invasive Species**	**Forest Health**
Cataract Creek Headwaters	2.7	2.7	2.0	1.0	2.0	2.0	1.0
Devil Dog Canyon	2.0	2.0	2.0	1.0	2.0	2.0	1,0
Dogtown Wash	2.7	2.7	3.0	1.0	2.0	2.0	1,0
Johnson Creek	2.3	2.3	2.0	1.0	2.0	2.0	1,0
Meath Wash	2.0	2.0	2.0	1.0	2.0	2.0	1.0
Upper Hell Canyon	2.7	2.7	2.0	1.0	2.0	2.0	1.0

Runoff impounded in seven reservoirs serves as the primary water supply for the City of Williams. These reservoirs have a combined water storage capacity of 2,755 acre-feet (897 million gallons) of water. Table 3 below lists the seven reservoirs in the Williams Municipal Watershed, their approximate water storage capacities and percentages of total available surface water supply. Water from these reservoirs originates from snow melt and summer precipitation.

Table 3. Reservoirs, associated water storage capacities, and percentages of total municipal surface water in the City of Williams Municipal Watershed.

Reservoir Name	Water Storage Capacity (Million Gal.)	Water Storage Capacity (Acre-feet)	Percent of Total Water Storage Capacity
Dogtown	360	1,105	40.2
Kaibab Lake	300	921	33.4
Cataract	109	335	12.2
Santa Fe Reservoir	70	215	7.8
City Dam	36	111	4.0

Upper and Lower Saginaw	22	68	2.4

Overstory Vegetation

The base of Bill Williams Mountain is primarily surrounded by ponderosa pine cover type. The southwestern slope of the mountain consists of dry ponderosa pine and gradually transitions to Douglas-fir and white fir at higher elevations. The northeastern slope of the mountain consists of Douglas-fir and white fir cover types with scattered aspen and ponderosa pine. Stands within the project area that average above 40% slope represent 17% of the project area.

The ponderosa pine cover type is approximately 65% of the project area. Some ponderosa pine stands are on the steep slopes of Bill Williams but mainly are on lower slopes surrounding the mountain. This type includes a mix of ponderosa pine, white fir, gambel oak, and alligator juniper. White fir is more apparent in these stands closer to the base of Bill Williams Mountain.

Mixed hardwood and oak woodland cover types are generally on the slopes of the mountain with smaller isolated stands at the base. Mixed hardwoods are comprised of gambel oak, choke cherry, maple, mountain mahogany and cliff rose. Oak woodlands are predominantly composed of gambel oak mixed with scattered ponderosa pine, Douglas-fir, white fir and alligator juniper. In general, drainages that lead off the slopes of Bill Williams Mountain are moister micro sites and are primarily regenerating in white fir (Figure 1). As the drainages lead lower in elevation white fir becomes scarce.

Figure 1: White Fir regeneration within the City Project Area at the base of Bill Williams Mtn. White fir trees provide ladder fuels and are associated with historically stand replacing fire regimes.

Compared with pre-settlement evidence, vegetation on the benches between drainages has become denser and has experienced crown closure of Douglas-fir and ponderosa pine. Crown closure has encouraged significant white fir regeneration which is invading the understory (Figure 2).

Figure 2: Located along the Bill Williams Lookout Road. This picture shows white fir regenerating under legacy ponderosa pine.

Aspen stands occur on the mountain and remnant aspen trees can be found in other cover types. Recruitment of aspen is generally isolated to scree and rock out crops where overstory competition is minimal and ungulate browse is light. Most stands of aspen on Bill Williams Mountain consist of larger older trees and are being encroached and replaced by conifers.

Pinion and Juniper woodlands comprise approximately 10% of the project area and are concentrated in the western portion. Juniper and pinion-juniper sites are primarily stocked with alligator juniper but often have scattered ponderosa pine, gambel oak, utah juniper, and pinion pine. The acre distribution of all the cover types is displayed in the table below.

Vegetation Cover Type	Acres	% of Project
Ponderosa Pine	10,554	69%
Oak Woodland	717	5%
Douglas Fir	299	2%
White Fir	1,619	11%
Pinyon-Juniper	654	4%
Juniper Woodland	947	6%
Mixed Hardwoods	146	< 1%
Aspen	140	< 1%
Grasslands	64	< 1%
Mountain-mahogany	40	< 1%
Rockland	22	< 1%
TOTAL ACRES	**15,202**	

Diversity and Sustainability

The high density of similarly aged trees in the project area impedes the development of grasses, forbs, and shrubs in the forest understory. Some stands also have a large number of fairly even-

aged trees which is hindering the regeneration and development of younger trees in the understory. Because of these factors, the forested landscape in the project area is less diverse and more uniform in age and structure than desired (Figure 3).

Figure 3: Bill Williams Trail within MSO PAC. Photo shows MSO habitat, aspen clones in decline & uniform forest structure. Trees in foreground are 9 to 16" DBH.

Over the past 10 years there has been a significant decline in aspen vigor in most of these sites. Aspen mortality in these sites ranges from 40% to almost 100%. This mortality is related to a number of factors including drought, past late freezes, insect attacks, and disease. In response to these disturbances aspen start sprouting from their root systems. New aspen development within the project area is being seriously impacted by ungulate browsing and overstory competition. This is leading to the potential for the complete loss of many of these aspen sites.

Many natural meadows, grasslands, open savannahs and forest openings within the project area are being reduced in size and number by the encroachment of ponderosa pine, juniper, and oak. These meadows and open areas provide areas of high grass/understory plant productivity and diversity which benefit wildlife species that utilize grass, forbs, and shrubs for feed and low hiding cover. The Kaibab National Forest and Arizona Game and Fish Department have worked together to identify an antelope travel corridor south of the Bill Williams Mountain area and into the southwestern edge of the project boundary. This area was identified as a priority area for restoration treatments in the midscale assessment document: South Zone Grassland Restoration Assessment for the Tusayan and Williams Ranger Districts, Kaibab National Forest (USDA Forest Service, 2007).

The Bill Williams Mountain project area also hosts unique plant and wildlife species habitat. Mexican spotted owls (*Strix occidentalis lucida*) have historically inhabited the mountain at its highest elevations. Other species such as Arizona bugbane (*Cimicfuga arizonica*), Mexican whip-poor-wills (*Tapacminos cuerporruin*), and Cassin's finches (*Carpodacus cassinii*) inhabit the higher reaches of the Bill Williams Mountain. Additionally, habitat for peregrine falcons (*Falco peregrinus*), northern goshawks (*Accipiter gentilis*), golden eagles (*Aquila chrysaetos*),

pronghorn antelope (*Antilocapra americana*) and Gunnison's prairie dog (*Cynomys gunnisoni*) occurs within the project area.

Insect and Diseases

Insects, diseases, and mistletoe infections are naturally occurring agents of disturbance that create snags and other important microhabitat for wildlife; however, uncharacteristic outbreaks of these change agents can lead to a widespread die-off of forest ecosystems. Insects and diseases outbreaks have occurred throughout the project area. Between 2000 and 2003, fir engraver beetles affected larger fir trees across the mountain leaving high densities of white fir snags on the steep mountain slopes. Other bark beetles such as Ips and western pine beetle were also active in the project area during the last drought. Mortality from these bark beetles often occurred in ponderosa pine, Douglas-fir and pinion. Currently bark beetles are not at epidemic levels but do exist in the project area.

Dwarf mistletoe infection levels in the project area are very high. This tree parasite slows the growth of trees and can eventually lead to tree mortality. Young ponderosa pine infected from the overstory will often succumb to mortality long before they mature. Mistletoe-created witches' brooms also add to the forest fuel ladder that aids ground fires in moving into the overstory canopy. Left unmanaged, these sites cannot be maintained in a sustainable uneven-aged condition.

Fire and Fuels

Fire is a natural component of the forested ecosystem in northern Arizona. In the past, lightning-caused fires burned across the forested landscape every few years. Fire was the process that thinned the forest and kept it open on dryer slopes and benches. On lower slopes, fires burned often and at low intensities through grasses and light fuels of an open forest. In drainages and on higher north facing slopes fuel moistures were higher which allowed greater tree densities and longer fire return intervals. The mixture of slope, aspect, and landforms (drainages and benches) made fire severity highly variable on Bill Williams Mountain.

Due to the spatial arrangement of high density trees and fuels, the slopes of Bill Williams Mountain currently pose a high risk of stand replacement crown fire. Fuel loadings within the project area range from 6-20 tons per acre in the ponderosa pine type to 12-45 tons per acre in the mixed conifer. Closed tree canopies with understory tree regeneration create "ladder fuels" to carry surface fires into the overstory. The ponderosa pine type and mixed conifer forest within the project area is at a high risk for stand-replacing wildfires while the risk for the woodland types in the project area ranges from low to high. Stands on the slopes of the mountain are at high to extreme risk for crown fire.

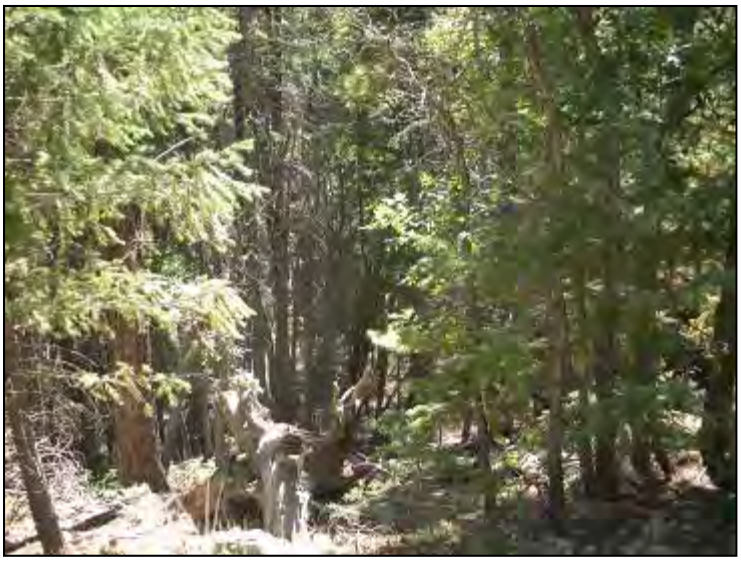


Figure 4: City Project EA Boundary, South Base of Bill Williams Mountain. Low crowns, dense conditions pose a risk for crown fire.

The Bill Williams Mountain project area is within the Wildland Urban Interface boundary as defined by the Greater Williams Area Community Wildfire Protection Plan (City of Williams, 2005). The area contains developed private inholdings. Much of this privately held land has homes and other structures. Crown fires threaten not only the homes and property in these areas but also the safety of the residents. Firefighter safety is a great concern in urban interface areas when wildfires are burning. Firefighters cannot be safely placed in dense stands of trees to suppress wildfires.

Desired Condition

The Project's Interdisciplinary Team (IDT) developed a specific desired condition for the Bill Williams Mountain project area based on "Management Direction" found in the Forest Plan. The desired condition consists of long-term goals for the project area. In many cases it may take many years for the project area to reach some of these goals.

In general, forest conditions would provide for diversity within stands without sustaining crown fire. These conditions would allow managers to use wildfire and prescribed fire to maintain the area as a functioning ecosystem without causing loss of ecosystem function or to human safety, lives and values. The desired condition would mimic reference conditions of pre-Euro-American settlement and follow the Kaibab National Forest Plan direction to:

- Protect human life and improvements.
- Treat fuel accumulations to abate fire risk.
- Not allow fires to spread to lands of other ownership.
- Minimize acreage burned by high-intensity fires.
- Protect and enhance wildlife habitat.

Within the Ponderosa Pine cover type:

- Ponderosa pine cover type outside of goshawk post-fledgling family areas (PFAs)/nests and outside of Mexican spotted owl (MSO) Protected Habitat (Protected Activity Centers and pine-oak sites having a slope greater than 40%) and Target/Threshold Habitat
  Tree density, spatial orientation, and species distribution of trees in the ponderosa pine cover type will be maintained in a state that is close to vegetative reference conditions. Vegetative reference conditions are vegetative conditions that existed in the project area over 140 years ago prior to Euro-American settlement of the area. (See the Vegetative Reference Conditions section below for a more complete definition of vegetative reference conditions.) Stands will be fairly open (approximately 10 to 50 trees per acre or 10 to 50 ft^2 basal area per acre) with groups of ponderosa pine surrounded by 30 to 80% open interspaces with scattered individual trees. Stands will be uneven-aged with enough younger trees developing in the understory to replace larger trees over time as they are lost to mortality. Understory grasses, forbs, and shrubs will increase in diversity and abundance. The risk of stand-replacing wildfires will be low.
- Ponderosa pine cover type within goshawk PFAs
  The ponderosa pine cover type will be composed of a diversity of multiple age classes as specified for goshawk post-fledging areas (PFAs) in the Forest Plan. This distribution will be composed of approximately 20% old growth forest (vegetative structural stage 6), 20% mature forest (vegetative structural stage 5), 20% mid-aged forest (vegetative structural stage 4), 20% young forest (vegetative structural stage 3), and 20% very young forest (vegetative structural stages 1 and 2). Canopy densities of vegetative structural stage (VSS) 4, 5, and 6 groups of trees will be maintained at levels above those specified in the Forest Plan (50 to 60% canopy cover). Tree spacing is non-uniform and clumpy. The risk of stand-replacing wildfires will be lower but still be moderate.
- Ponderosa pine cover type within goshawk nest sites
  These sites will be composed mostly of VSS 5 and 6 groups of trees. Canopy cover will be between 50 to 70%. Tree spacing is non-uniform and clumpy. Tree density and fuel loadings will be maintained at a level that reduces the risk of stand-replacing wildfires below current risk levels. This risk will generally be moderate to moderate/high.
- Ponderosa pine cover type within Mexican spotted owl (MSO) Protected Habitat
  Forest patches (i.e., “groups”) of 2.5 acres in size or greater will occur throughout these areas. A range of patch sizes will exist: Larger patches will occur on northeastern slopes and drainages, and smaller patches (at least 2.5 acres) will occur on southwestern slopes and on dry ridgetops. Patches of all ages will occur throughout the area. They will be comprised of a diversity of seral stages, with most patches dominated by large trees (>18” DBH). Patches dominated by large trees will retain interlocking crowns and high canopy cover, and those dominated by smaller trees will develop interlocking crowns and high canopy cover over time. Manage for an average canopy cover of at least 60%. Openings will range in size between 1-2 acres and have very few, if any, trees. At least 2 large snags (>18” DBH) per acre will occur, on average. Large oaks will be retained, and more large oaks will develop over time. These areas will be managed with an emphasis on horizontal and vertical heterogeneity; tree species diversity (including a mixture of hardwoods and shade-tolerant species); diverse composition of vigorous native herbaceous and shrub species; and healthy levels of residual biomass and down logs (especially those >12” midpoint diameter). Tree density and fuel loadings will be maintained at a level that

reduces the risk of stand-replacing wildfires below current risk levels. This risk will generally be moderate to moderate/high. These desired future conditions reflect the best available science and science-based recommendations for management of MSO nesting/roosting habitat, as they derive from the newly revised MSO Recovery Plan (released in June, 2011).

- Ponderosa Pine cover type within MSO Target/Threshold Habitat
  These sites will have conditions at or above MSO nest/roost characteristics that are specified in the Forest Plan (150 ft^2 basal area per acre; twenty 18" or greater diameter trees per acre; VSS 4, 5, and 6 groups will each have 15% or more of total site stand-density index [SDI]; 20 ft^2 basal area per acre of oak). Tree density and fuel loadings will be maintained at a level that reduces the risk of stand-replacing wildfires below current risk levels. This risk will generally be moderate to moderate/high.
- General desired conditions for the ponderosa pine cover type
  - Dwarf mistletoe will be present, but infection levels will be maintained at a manageable level that allows for sustainable uneven-aged management.
  - A variety of oak and juniper size and age classes will be maintained in areas where these species were part of the vegetative reference condition. Age class distribution of oak and juniper will be such that some large oak and juniper are always maintained in these areas.
  - Large trees of all species will be developed throughout the cover type and many are allowed to attain a very old age. In particular, trees greater than 24" DBH would continue to occur at existing levels or higher and risk of mortality of these trees from wildfires or prescribed burning will be low.
  - Fuel loading will average 5 to 7 tons per acre in most of the goshawk habitat in the ponderosa pine type. Fuel loadings will be maintained at lower levels in the wildland-urban interface and in areas along major roads that can be used as fuel breaks.

Mixed Conifer:

- Mixed conifer cover type outside goshawk PFAs and MSO Protected and Target/Threshold Habitat
  The mixed conifer cover type will be composed of a diversity of multiple age classes as specified for landscapes outside of goshawk PFAs in the Forest Plan. This distribution will be composed of approximately 20% old growth forest (vegetative structural stage 6), 20% mature forest (vegetative structural stage 5), 20% mid-aged forest (vegetative structural stage 4), 20% young forest (vegetative structural stage 3), and 20% very young forest (vegetative structural stages 1 and 2). Densities of vegetative structural stage (VSS) 4, 5, and 6 groups of trees will be maintained at levels above those specified in the Forest Plan (40 to 60% canopy cover or 50 to 60% canopy cover in goshawk PFAs). Tree spacing is non-uniform and clumpy. The risk of stand-replacing wildfires will be moderate.
- Mixed conifer cover type in goshawk nest sites
  These sites will be composed mostly of VSS 5 and 6 groups of trees. Canopy cover will be between 50 to 70%. Tree spacing is non-uniform and clumpy. Tree density and fuel loadings will be maintained at a level that reduces the risk of stand-replacing wildfires below current risk levels. This risk will generally be moderate to moderate/high.

- Mixed conifer cover type within Mexican spotted owl (MSO) Protected (Protected Activity Centers or MSO mixed conifer sites having a slope greater than 40%) or Target/Threshold Habitat
  Forest patches (i.e., "groups") of 2.5 acres in size or greater will occur throughout these areas. A range of patch sizes will exist: Larger patches will occur on northeastern slopes and drainages, and smaller patches (at least 2.5 acres) will occur on southwestern slopes and on dry ridgetops. Patches of all ages will occur throughout the area. They will be comprised of a diversity of seral stages, with most patches dominated by trees greater than 18" DBH. Patches dominated by large trees will retain interlocking crowns and high canopy cover, and those dominated by smaller trees will develop interlocking crowns and high canopy cover over time. Manage for an average canopy cover of at least 60%. Openings will range in size between 1-2 acres and have very few, if any, trees. At least 5 snags greater than 18" DBH per acre will occur, on average. These areas will be managed with an emphasis on horizontal and vertical heterogeneity; tree species diversity (including a mixture of hardwoods and shade-tolerant species); diverse composition of vigorous native herbaceous and shrub species; and healthy levels of residual biomass and down logs (especially those >12" midpoint diameter). Tree density and fuel loadings will be maintained at a level that reduces the risk of stand-replacing wildfires below current risk levels. This risk will generally be moderate to moderate/high. These desired future conditions reflect the best available science and science-based recommendations for management of MSO nesting/roosting habitat, as they derive from the newly revised MSO Recovery Plan (released in June, 2011).
- Mixed conifer cover type within MSO Target/Threshold Habitat
  These sites will have conditions at or above the MSO nest/roost characteristics that are specified in the Forest Plan (150 to 170 ft^2 basal area per acre; twenty 18" or greater diameter trees per acre; VSS 4, 5, and 6 groups will each have 10% or more of total site SDI). Tree density and fuel loadings will be maintained at a level that reduces the risk of stand replacing wildfires below current risk levels. This risk will generally be moderate to moderate/high.
- General desired conditions for the mixed conifer cover type
  - Dwarf mistletoe will be present, but infection levels will be maintained at a manageable level that allows for sustainable uneven-aged management.
  - Where an aspen component currently exists within mixed conifer sites, aspen will be maintained as a viable stand component over time.
  - Large trees of all species will be developed throughout the cover type and many are allowed to attain a very old age. In particular, trees greater than 24" DBH would continue to occur at existing levels or higher and risk of mortality of these trees from wildfires or prescribed burning will be low.
  - Fuel loading will average 10 to 15 tons per acre in most of the goshawk habitat in the mixed conifer type. Fuel loadings will be maintained at lower levels in urban interface areas and in areas along major roads that can be used as fire control lines.

Woodlands:

- Woodlands will be maintained at stocking levels that are much closer to reference conditions. The exception to this would be areas within oak woodlands that are identified

as part of MSO Protected Activity Centers and woodlands within goshawk PFAs. These areas will have higher densities as specified in the Forest Plan. Grass and forb production and species richness will be high, relative to site productivity, in juniper and pinion-juniper woodlands and moderate to high in oak woodlands. Woodlands will be in an uneven aged condition that sustains a mosaic of vegetation densities, age classes, and species composition.

Grasslands:

- Grasslands will be maintained as open meadows or very open savannahs. Tree stocking will be maintained close to vegetative reference conditions. Grass and forb production will be at or close to the full potential for the site.

Aspen:

- Aspen sites will be vigorous and free to grow without excess competition from conifers. As older aspen are lost to mortality, new aspen can sprout and freely grow into replacement trees. Where aspen exists within mixed conifer or ponderosa pine sites, some openings in the overstory will be maintained over time to allow for aspen regeneration and development. Aspen will be maintained across the landscape at current levels or above, and the diversity of plants and animals that occur in these stands aspen will be improved.

Fire and Fuels:

- Surface fuels are to average less than 7 tons per acre in pine and pine-oak forests and 10 tons per acre in mixed conifer forests.
- Conditions within the project area would have an average stand canopy base height (CBH) above 18 feet with canopy bulk densities (CBD) below .05kg/m3 in ponderosa pine forest types and CBH above 10 feet in with CBD of .08kg/m3 in mixed conifer types.

The Entire Project Area:

- The probability of stand-replacing wildfire will be reduced on and surrounding Bill Williams mountain, thereby conserving the capability of the watershed to provide clean and abundant water to the city of Williams.
- All six subwatersheds in the project area will be in good condition with little unsustainable erosion/sedimentation and, where feasible, soils in unsatisfactory condition would be improved.
    - Herbaceous vegetation, woody debris, and fine litter would be at sufficient levels (on average less than 50% bare soil) to protect soil surfaces from raindrop impact and minimize soil erosion in treated watersheds.
    - Poorly located roads and roads in a state of disrepair would be relocated or obliterated to reduce sedimentation and channelization of drainages.
- Periodic understory fires will be reintroduced into the area.
- Fuel loadings and fire ladders will be maintained at low levels in the wildland-urban interface and in areas along major roads that can be used as fire control lines. Overall area fuel loading will be low to moderate.

- A spectrum of high quality outdoor recreation settings and opportunities will be available in the Bill Williams Mountain project area.
- Sustainable scenery is highly dependent upon ecosystem health. Scenery will be restored to historic conditions in most areas and these provide durable, attractive attributes. Middleground and background views will have healthy historic forest patterns and forest cover conditions. Foreground views will have diverse forest cover displaying many large trees as well as all other ages of trees. There will be spatial variation of forest and openings.
- Noxious weeds will be maintained at a very low to nonexistent level.
- Rangeland will be in satisfactory condition.
- There will be a diversity of cool and warm season plants.
- Threatened, endangered, and sensitive species will occur at similar or higher population sizes as today.
- Key habitat components for threatened, sensitive, and management indicator species (MIS) will be maintained over time throughout these species' habitat.
    - Oaks and other hardwoods greater than 10 inches diameter at root collar (DRC), down logs greater than 12" midpoint diameter, and snags greater than 18 inches diameter at breast height (DBH) are conserved at existing or higher levels.
    - Trees greater than 18" DBH with spiked tops, lightning strikes, fading crowns, and other characteristics ideal for wildlife occur at existing or higher levels.

The Vegetative Reference Condition

Reference conditions are those vegetative conditions that existed on this forest at a point of time prior to Euro-American settlement of the area. This analysis uses the year 1870 as a reference point because it is just prior to Euro-American settlement of the area and it is a point in time where we can fairly easily estimate past tree stocking by looking at presettlement evidence that still exists on the site (old trees, stumps, fallen trees, stump holes). Reference conditions more closely represent the conditions that probably existed on the forest for a long period of time than current conditions do. This is because the reference point is chosen at a point of time prior to heavy vegetative manipulation of the area from grazing, fire exclusion, and logging that occurred after the late 19th century. Also, long-term climatic conditions have not varied to a great extent since the last ice age (10,000 years ago). Many studies confirm that there has been a drastic change in the forest state, particularly in respect to increased tree density, over the past 140 years. Visual observations of presettlement evidence in the project area indicate that ponderosa pine cover type reference condition average tree density ranged from 5 to 30 trees per acre compared to a current average tree density of approximately 500 trees per acre. Woodland and mixed conifer cover types have also significantly increased in tree density from reference conditions